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EVALUATION OF INDUSTRIAL PROJECTS
Project Formulation and Evaluation Series, Volume I

EVALUATION OF INDUSTRIAL PROJECTS

Selected studies presented at the Interregional Symposium on Industrial Project Evaluation held in Prague, Czechoslovakia, 11 to 20 October 1966

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New York, 1966
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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 definite, they are the variables of the model. Computations should determine the volume (quantity) of $x_{1,1}, x_{1,2}, \ldots, x_{1,8}$.

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:

1. What quantity of each product should be produced in 1970?
2. What are the projects for which technology should be constructed during 1970-1970 in order to achieve optimum production in 1970?
3. What should be done with the old capacities existing on 1 January 1970? Are they still worked, or are they being reconstructed or discarded?
4. What kind and what size of new factories should be built?
5. 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 $x_{1}$ 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
The purpose of the present paper is to consider some of the important issues and problems related to the evaluation of industrial projects, and to examine the consequences of inadequate or inappropriate approach in this area. The emphasis is on the role of the environment in industrial development, and on the need for a comprehensive and systematic approach to the evaluation of industrial projects.

The development of a comprehensive and systematic approach to the evaluation of industrial projects requires the consideration of a number of important issues and problems. These include:

1. The need for a comprehensive and systematic approach to the evaluation of industrial projects.
2. The role of the environment in industrial development.
3. The importance of considering the environmental impact of industrial projects.
4. The need for a comprehensive and systematic approach to the evaluation of industrial projects.

A comprehensive and systematic approach to the evaluation of industrial projects requires the consideration of the following:

- The need for a comprehensive and systematic approach to the evaluation of industrial projects.
- The role of the environment in industrial development.
- The importance of considering the environmental impact of industrial projects.
- The need for a comprehensive and systematic approach to the evaluation of industrial projects.

The evaluation of industrial projects should be based on a comprehensive and systematic approach that takes into account the environmental impact of the projects and the potential for sustainable development. This approach should be based on a comprehensive and systematic analysis of the environmental impact of the projects and the potential for sustainable development.

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common and that is to evolve comparable understandings in the form of standards or models to improve these problems.

I. SUMMARY OF THEORETICAL FOUNDATIONS

The theory and practice of planning in countries with centrally planned economies and in countries with market economies differ widely.

In both types of economies there exists a gap between the theory and the practice of industrial development planning. This gap is a result of an attempt to narrow the gap between the two. The need for industrial planning evaluation is a relatively new approach to economic planning analysis and as such is still at a preliminary stage.

In countries with centrally planned economies there appears to be a certain difference of opinion on 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 cannot be taken for granted by the many planning agencies. The application of any developed operational techniques should be slow because of the limitations of computing facilities available to the planning agencies, and the collection and transmission of the required data are also required. The planning agencies are behind the development of new techniques but are unable to manage them in their current state.

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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 a valuation and formulation procedure on a more permanent basis.

Two other limitations must be mentioned. First, the bulk of attention is focused exclusively on the problems of the developing countries. Most of the comments made would be applicable to industrialized countries. Secondly, the specific experience on which many of these comments are based relates to Latin America. How far the inferences drawn are valid for the developing countries as a whole is another matter for possible consideration by the Symposium.

A number of the various levels at which industrial development programming takes place in Latin America, and the nature of the industrial strategies associated with special reference to trends towards the adoption of a middle way represented by the formulation of an industrial strategy and its incorporation into the strategic investment programme within an overall, more or less explicitly defined framework of overall development planning are set out in section IV.

Four problems, a group of problems, are next considered in the context of the operation of the evaluation and selection of projects, to determine industrial development programming in developing countries.

The effect of profitability criteria in the establishment of the sectoral targets in which a given industrial strategy is reflected is set out in section V.

The difficulty of influencing private sector investment decisions by the light of social profitability criteria is set out in section VI.

The less reliable character of economic profitability criteria in developing countries and the difficulties resulting, therefore, in connexion with the channelling of industrial development are set out in section VII.

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 described in sections II and III and procedures for the application of such programmes are then considered in some detail. Emphasis being laid on the problem of ensuring future efficiency levels, which is of basic importance in any project for the modernisation of existing industry and in 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 inter-sectoral order of precedence is established directly, the priority sectors, and even the production and investment targets for each, are expressed explicitly, the latter forming an integral part of an over-all development programme designed to maximise national income and output, 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 being not yet in the majority in Latin America.

In other instances, industrial development priorities are assigned indirectly, through the premonstration of priority criteria for the approval of individual investment projects, based on the potential contribution of each undertaking to the earning 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 utilisation of raw materials and natural resources in particular 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
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 attitude, procedures and methods which are obstructed by the resistance of attitudes, procedures and methods which are obstructed by the resistance of attitudes, procedures and methods which are obstructed by the resistance of persons who can do nothing to modify, such as raw material characteristics, can be corrected by themselves.

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.

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 by 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.\footnote{1}

\footnote{1} The Seminar on industrial programming held by the United Nations at Sao Paulo, Brazil, in March 1968 (see Report of the United Nations Seminar on Industrial Programming, United Nations publication, Sales No. 64 II B.1), analyzed Latin America's experience in the field of industrial programming, in connexion with the recent efforts 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.

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 the following line-up of the main problems of productivity and performance by personnel in the manufacturing industry:

\begin{itemize}
  \item \textit{ECLA 1941 416.}
\end{itemize}
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 industries. On the one hand, the establishment of production targets are laid down as a component to the endeavour to expand output through the improved use of current investment, and on the other, the set of industrial policy measures to be designed as to be applicable, as far as possible, both to new undertakings, and to the modernization of those already in operation.

The overall approach to the programming of a whole industrial sector thus covers both existing assets 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, are too well known to need discussion here. In the present report, calculation 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, co-ordinately 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 consideration made by the evaluation and selection of projects, through the above-mentioned conceptual procedures, to the determination of the programme targets. The question then is to be asked anew how the sectoral production and investment and operational efficiency objectives the government makes 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, apart 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 selection 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 procedures 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 (necessitated by a presponderantly 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 PRIORITIZATION 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 percent, on an average, is earmarked for the expansion of industrial sectors already existing on the country concerned (only 20
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—practices wherever it merits or shortcomings, not likely to be easily modified in the near future, makes the fulfillment of the first condition difficult. The second condition would entail mainly the manipulation of the whole credit system and the fiscal and customs tariff regimes in terms of those targets and priorities, and could be achieved only through the establishment of an industrial strategy to the industrial 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 a 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 projects 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 minimum solution since it would absorb all the available resources."  

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 undesirable 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 price by indirect measures mainly taxation. In order to perma-made a part of the private sector to follow the desired course. While it is recognized that vast possibilities are opened up by the economic policy deliberately aimed at correcting the deficiencies in the price system, it is not always possible to expect too much from such a community when the price of industry as opposed to public utility. Furthermore, the adoption of indirect measures would be subject to regional development planning. The shadow price would be very uncertain in such circumstances.

Another factor which makes it difficult to apply a group of projects in order of profitability or quality in terms of their economic price or social, without regard to an overall investment strategy in a development plan, is the manner in which the economic framework within which projects are calculated. Some parts of this methodology on Latin America's experience are given below.

Conditions of extreme inflation, a factor that distorts the basis for evaluation by the single product and factor price.

An unstable market reserve against protective import subsidies in which governments constantly change both in regard to the protected and the level of protection in terms of the foreign payments situation.

Emerging exchange rate fluctuations in an unstable system for the international transmission of prices and costs which is necessary for readjustment in a decision on whether or not to undertake industrial or construction as a possible alternative to present.

Other factors which require separate project cost tests for particular projects include the costs of the project, external effects, types of production, the development strategy, or the political and social factors, the costs into account do not exist being over one project.

United Nations publication Sales No. 64.I.1.50
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 entrepreneurial 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.

F. 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, poses unmanageable 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 reequipping the textile industry, for example, makes it possible to obtain investment decisions. Choice of techniques and equipment must be 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 concede with those resulting from spontaneous entrepreneurial initiatives.

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, 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. 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 as a result of reequipment (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 industries in Latin America II (United Nations publication, Sales No.: 6411.2), chapters VIII and IX.

* 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.
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,19 those factors are not chiefly responsible for the variations in manpower productivity.20 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 subcontracted 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

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19 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, 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 1.1 to 3.9 (66 to 794 spindles per man, respectively) The same is true of other counts. See The textile industry in Latin America, II. Brazil, pp. 78, 79.

20 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 projects 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 5,000 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 practiced on a very small scale. Consequently, this model 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 once 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
meeting the needs of the precision engineering sector and gradually replacing specialized workers from abroad. Such a programme would also be started on technical standards and technological research, in existing institutes, which would thus be able to improve their level of work.

Finally, the precision products envisaged in the programme would require, in order to be produced economically, production units 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 prime factor in the location of a large precision-engineering industry in Uruguay.

Here the need would be to plan the establishment of an industry in Uruguay at one and the same time of a group of enterprises with a technological level on a par with the processes and equipment used, value added per worker or any other concept, appreciably higher than that existing in the equivalent industry.

How can the economic viability of such an undertaking be assured? First of all, the establishment of the new activity cannot be an autonomous action by the machinery's application of the group of enterprises envisaged for which constitute a second-stage programme. But, in addition, the standardization of purchasing bodies must be carried out in such a way that the quality of the groups' production meeting plans will be guaranteed as it would be in the defective internal operation on the earlier terms concerned.

In the context of such a second-stage programme, the evaluation of the profitability of an individual enterprise has not the same importance as the evaluation of the performance of the whole group. The new enterprises will have to achieve, for the performance levels of more advanced countries, the targets of which, of course, will greatly depend on the effective application by the group of the necessary instruments to the industrial enterprises' second-stage programme. These performance levels, thus predictable entail a relatively high degree of gratification, and no final decision on the worth of an enterprise' based on their.

But the decision to develop an export sector within the colás del universo scheme was taken as part of a general strategy of development, which the various texts of which formed a general policy of export orientation. In no way depended the profitability or the position of the programme on the content of the initial programme, or that of other projects in other industrial sectors. Other experiments are being planned, but it is part of them that for the expansion and modernization of the industrial sector concerned such as the woolen 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 woolen textile industries. However, the development of a precision-engineering sector has advantages, in terms of introducing a dynamic growth factor 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 not 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 explicit concept of an industrial strategy as part of a development plan or programme. Hence caution is also advised against too much confidence in applying conventional evaluation and selection criteria, so as not to give a false appearance of accuracy through the application of refined evaluation procedure 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 the term 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 evaluation 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 metal mecánica de Venezuela: un programa de sustitución de importaciones para su desarrollo," ECLAC 12/235, 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 ele-
ments that entered into the economic calculations
must be kept within the original estimates, and this
leads to the specific and detailed knowledge of what
those projections are and what hypotheses they
represent.

Second, 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 cri-
terion or criteria according to which profitability is
defined. This is the approach used in project evalua-
tion, for example, in the sphere of national develop-
ment 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 formu-
lated 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 coun-
tries, at least in Latin America, to explain the ob-
stacles in the way of a more rapid industrial develop-
ment as the result of the lack of projects, or the
difficulties in preparing projects. There is an un-
deniable shortage of projects formulated in the in-
dustral field, but the dearth of projects cannot be
automatically explained by the lack of agencies
devoted to their preparation, or unsatisfactory per-
formance 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 funda-
mental 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 entre-
preneurial 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 shar-
ing 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 up-
surge.

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

A broad knowledge of resources, markets and
technologies, essential for entrepreneurship, is not
always present even 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 proportion
in each case, would appear to lie behind the low
number of projects that 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 tight conditions for
taking investment decisions, and hence for the formu-
lation of the corresponding projects.

The experience of SUDENE in promoting a
broad and well organized programme for the
modernization and reequipment of the textile indus-
try in northeastern Brazil is a good illustration of the
above arguments. This programme, begun in 1962,
provides extensive tax privileges and some
financing for enterprises that present projects for
modernization and reequipment and submit plan-
etary approval to the regional development authori-
ties.

The actual preparation of projects has likewise
encouraged and facilitated by SUDENE, who have
worked out a model project to cover a range of
enterprises.

In July 1964, after nearly two and one half years
of application, a balance sheet was drawn up on
the re-equipment of the textile industry in north-
eastern Brazil. This showed that despite the high
hopes, the results were disappointing, so far as
regards project elaboration.

The situation may be summed up in a few words. Of the sixty one indus-
trial establishments covered by the programme's thirty
three submitted projects of the twenty eight that
tried 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 mil, some were simply not interested in

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 1984, twenty had been approved and seven were being analysed by SUDENE or by the Banco do Nordeste do Brasil. 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.\footnote{This is not the place for an analysis of these obstacles. Sufficient 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.}

\footnote{The financial agency which operates under the jurisdiction of SUDENE.
III. PROJECT EVALUATION AND THE CONSISTENCY OF THE PLAN

by C. Cahor

A. INTERRELATIONS BETWEEN INDIVIDUAL PROJECTS AND OVERALL SECTORAL DEVELOPMENT PLANS

Efficient use of available resources is the main prerequisite for the development of every economic unit, regardless of its 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 overall (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 at least to approximate the most efficient use of resources in 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 the 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. The same factor or product may 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 project, the simultaneous realization of these projects will be impossible. 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.

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The development of any long-range economic development plan is necessarily concerned with the economic growth of the area and with the task of development in such countries as those of the United States and Canada and in such regions as the Far East, the Mediterranean, and the Middle East. These countries are characterized by a rapid rate of industrialization, a high rate of population growth, and a high degree of urbanization.

The development plan is a complex of economic and social activities, and the economic development of the area is necessarily considered as an integral and essential part of the overall plan. The economic development plan is necessarily concerned with the economic growth of the area, the development of a high rate of industrialization, and the rapid rate of population growth. The economic development plan is necessarily concerned with the economic growth of the area and with the task of development in such countries as those of the United States and Canada and in such regions as the Far East, the Mediterranean, and the Middle East. These countries are characterized by a rapid rate of industrialization, a high rate of population growth, and a high degree of urbanization.

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The problem of demand for electric energy is an important one in the development of nations and the establishment of new industrial areas. In this paper, methods of estimating the demand for electric energy are discussed. The methods are based on the assumption that the relationship between electric energy consumption and national income is a function of production which is described in the paper by the author. A mathematical model is proposed which can be used to predict future electric energy consumption.

The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. This method is similar to the methods used by other authors. The method is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. 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The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production. The mathematical model is based on the assumption that the relationship between electric energy consumption and national income is a function of production.
of planning in the socialist countries where we know, various balances play a very important role. However, balances for electric energy are worked out even in countries where elsewhere there is no formal planning of the economy. As already mentioned, the planned balance of electricity production adheres 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 and 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. Hence in connection with consistency and efficiency it should be pointed out that from the social point of view consistence 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 "interference" would certainly be wasteful inefficient utilization of resources. The opposite namely, lack of productive capacity to satisfy an existing demand, would also theoretical speak for example in underfilling of other plants that could not produce for lack of electricity to prevent 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 rest of planning seems to be increasing also in the developed market countries. However, structural changes are generally rather slow in developed economies. Thus, a new understanding of the input-output table is not so great and thus it brings the adaptation of production in changing situations through the market. In the developing countries the structural changes might be very rapid, the input-output of some new plants proportionately very important and the adaptability of the market very imperfect. This probably is one of the reasons influencing the governments of developing countries in favor 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 present balance in the production of electricity is a constraint and that the reserve of the existing power stations have been exhausted and new sources of electricity are desired. The balance in this case will measure only the quantities which are to be produced.
given information and conclusions. As a result of these discussions, a number of recommendations were suggested for further research. These recommendations include:

1. The need for more detailed studies on the impact of different factors on the performance of the proposed algorithms.

2. The importance of incorporating real-world data into the experiments to better understand the practical implications of the proposed solutions.

3. The necessity for developing new models and algorithms that can handle the complexity of the problem more effectively.

4. The requirement for more studies on the scalability of the proposed solutions, especially in the context of large-scale datasets.

These recommendations are intended to guide future research efforts and contribute to the advancement of the field of computational algorithms.
The first set of coefficients is designed to reflect the main effects of the increased production on the whole economy and on the whole industry, that is, its effects on the value added, employment, capital and imports. These categories are characterized 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 conveniently 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, 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. The assumption, as explained in the theory of the input-output models, is by no means justified.

However, to evaluate the direct 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, 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.

* 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>
<thead>
<tr>
<th>Industrial sector</th>
<th>Value added</th>
<th>Direct impacts</th>
<th>Indirect impacts</th>
<th>Total impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal mining</td>
<td>504</td>
<td>250</td>
<td>80</td>
<td>330</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>480</td>
<td>106</td>
<td>249</td>
<td>355</td>
</tr>
<tr>
<td>Non-ferrous metals</td>
<td>512</td>
<td>160</td>
<td>199</td>
<td>359</td>
</tr>
<tr>
<td>Non-electrical machinery</td>
<td>79.9</td>
<td>1.7</td>
<td>197</td>
<td>202</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>217</td>
<td>271</td>
<td>197</td>
<td>408</td>
</tr>
<tr>
<td>Precious metals</td>
<td>835</td>
<td>42</td>
<td>245</td>
<td>522</td>
</tr>
<tr>
<td>Electricity</td>
<td>851</td>
<td>224</td>
<td>109</td>
<td>343</td>
</tr>
<tr>
<td>Petroleum refining</td>
<td>79.6</td>
<td>106</td>
<td>119</td>
<td>244</td>
</tr>
<tr>
<td>Heavy chemicals</td>
<td>103</td>
<td>106</td>
<td>119</td>
<td>244</td>
</tr>
<tr>
<td>Wood products</td>
<td>866</td>
<td>119</td>
<td>144</td>
<td>283</td>
</tr>
<tr>
<td>Paper production</td>
<td>75.7</td>
<td>51</td>
<td>119</td>
<td>161</td>
</tr>
<tr>
<td>Cotton products</td>
<td>81.6</td>
<td>22</td>
<td>66</td>
<td>90</td>
</tr>
<tr>
<td>Leather production</td>
<td>64.1</td>
<td>28</td>
<td>63</td>
<td>99</td>
</tr>
<tr>
<td>Shoe manufacturing</td>
<td>84.4</td>
<td>15</td>
<td>121</td>
<td>151</td>
</tr>
<tr>
<td>Food products</td>
<td>84.7</td>
<td>16</td>
<td>121</td>
<td>151</td>
</tr>
</tbody>
</table>

* In formula, per 100 tones of output.

** In million formula of output.

The meaning of the coefficients of the capital requirement needs some further explanation. First of all, the output of the sector in question is compared to the amount of fixed capital effectively built in and measured by statistical observations, here called "effective fixed capital". Moreover, if we are interested in the requirement, the utilization of the built-in capacities has to be taken into account. Such utilization 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 capacities remained d in the effective production, a second capital coefficient is obtained, known as the requirement. The latter permits a more precise evaluation of the requirements for new investment than is possible through effective fixed capital coefficients. The production can be increased in the light of the expected extension of the existing equipment. As a result, the third coefficient reflects the 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 20 per cent in every sector.
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)

<table>
<thead>
<tr>
<th>Industrial sector</th>
<th>Imports</th>
<th>Total employment</th>
<th>Effective land use</th>
<th>Investment requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal mining</td>
<td>56</td>
<td>74</td>
<td>61</td>
<td>63</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>62</td>
<td>48</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>Non-ferrous metals</td>
<td>89</td>
<td>59</td>
<td>49</td>
<td>32</td>
</tr>
<tr>
<td>Non-electrical machinery</td>
<td>96</td>
<td>56</td>
<td>54</td>
<td>40</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>78</td>
<td>59</td>
<td>54</td>
<td>39</td>
</tr>
<tr>
<td>Precise instruments</td>
<td>58</td>
<td>76</td>
<td>51</td>
<td>36</td>
</tr>
<tr>
<td>Electricity</td>
<td>70</td>
<td>48</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>Petroleum refining</td>
<td>92</td>
<td>33</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>Heavy chemicals</td>
<td>78</td>
<td>54</td>
<td>37</td>
<td>29</td>
</tr>
<tr>
<td>Wood products</td>
<td>92</td>
<td>45</td>
<td>49</td>
<td>39</td>
</tr>
<tr>
<td>Paper production</td>
<td>79</td>
<td>70</td>
<td>54</td>
<td>41</td>
</tr>
<tr>
<td>Cotton textiles</td>
<td>79</td>
<td>70</td>
<td>54</td>
<td>31</td>
</tr>
<tr>
<td>Leather production</td>
<td>85</td>
<td>44</td>
<td>45</td>
<td>31</td>
</tr>
<tr>
<td>Shoe manufacturing</td>
<td>28</td>
<td>66</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>Food products</td>
<td>65</td>
<td>12</td>
<td>28</td>
<td>21</td>
</tr>
</tbody>
</table>

It 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.

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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.

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<td>59</td>
<td>49</td>
<td>32</td>
</tr>
<tr>
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<td>96</td>
<td>56</td>
<td>54</td>
<td>39</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>78</td>
<td>59</td>
<td>54</td>
<td>40</td>
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<td>58</td>
<td>76</td>
<td>51</td>
<td>36</td>
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<td>Electricity</td>
<td>70</td>
<td>48</td>
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<td>Petroleum refining</td>
<td>92</td>
<td>33</td>
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<td>78</td>
<td>54</td>
<td>37</td>
<td>29</td>
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<td>79</td>
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<td>31</td>
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<td>21</td>
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It 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-
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 \( x_1, x_2, \ldots, x_n \).

- \( x_1 \): production of electric energy from coal (kWh)/
- \( x_2 \): production of electric energy from crude oil
- \( x_3 \): production of 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

\[
\begin{align*}
a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n &= v_1 + s_1 \\
a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n &= v_2 + s_2 \\
a_{31}x_1 + a_{32}x_2 + \cdots + a_{3n}x_n &= v_3 + s_3
\end{align*}
\]

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,

\[
\begin{align*}
x_1 + x_2 + \cdots + x_n &= K_1 \\
x_2 + x_3 + \cdots + x_n &= K_2 \\
x_3 + x_4 + \cdots + x_n &= K_3
\end{align*}
\]

where \( d_1, \ldots, d_n \) denote the difference between the prices of domestic and imported source of energy.

The equations containing the balance of energy:

\[
\begin{align*}
&d_1y_1 + d_2y_2 + d_3y_3 + \cdots + d_ny_n \quad \text{minimum}
\end{align*}
\]

the balance of foreign exchange and the connections among the activities might also be written in the following manner:

\[
\begin{align*}
&b_1y_1 + b_2y_2 + b_3y_3 + \cdots + b_ny_n \quad \text{minimum}
\end{align*}
\]

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

<table>
<thead>
<tr>
<th>Source of Energy</th>
<th>Production</th>
<th>Electric Energy</th>
<th>Cement</th>
<th>Heating for Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>( a_{11} )</td>
<td>( a_{11} )</td>
<td>( a_{11} )</td>
<td>( a_{11} )</td>
</tr>
<tr>
<td>Oil</td>
<td>( a_{21} )</td>
<td>( a_{21} )</td>
<td>( a_{21} )</td>
<td>( a_{21} )</td>
</tr>
<tr>
<td>Natural gas</td>
<td>( a_{31} )</td>
<td>( a_{31} )</td>
<td>( a_{31} )</td>
<td>( a_{31} )</td>
</tr>
</tbody>
</table>

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

\[
\begin{align*}
&x_1 = b_1 + y_1 / \text{coal/} \\
&x_2 = b_2 + y_2 / \text{oil/} \\
&x_3 = b_3 + y_3 / \text{natural gas/}
\end{align*}
\]

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".

\[
\begin{align*}
d_1y_1 + d_2y_2 + d_3y_3 + \cdots + d_ny_n &= \text{minimum}
\end{align*}
\]

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

$$Ax = b$$

where $a$ 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

$$c x$$

subject to the constraint $Ax = b$ can be resolved by the method of linear programming not to be discussed here. The solution yields the quantities of sources of energy to be produced at home $x_v$ and those to be imported $x_i$ and their allocation to the different sectors using the model: this would involve great computational and even some theoretical difficulties. To avoid them, a method was proposed in Hungary by Messrs. Kornai and Lipáková known as "programming on two levels".

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 interconnections 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. 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 aluminum 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 of 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 Lipáková 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. If property applied, this method should make possible the selection of efficient projects and at the same time ensure consistency for the economy as a whole.


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 community in the project team from the inception of preparation to successful operation. Individual 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 form 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 large, is comparatively straightforward to be handled from internally generated funds. The project management will normally be familiar with the equipment needed and will be able to supervise installation and to integrate it into the plant with relatively little resistance. The report presentation thus be prepared well in advance of the specialized staff of the project team to whom the details of the proposal are given in some detail, with ample opportunity for scrutiny by government officials and businessmen. However, it is possible that the project is viewed as an entirely new type of
equipment must be considered, that new methods of marketing must be developed and new market outlets secured, that management skills must be increased so that careful consideration must be given to a wide 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 and agencies, and one or more of the international financing authorities. In such circumstances, a higher degree of formality is required.

It is probable that some degree of documentation will be required for even the smallest working capital loan, although some banks may 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 personal or head office loan authorizing officer or committee. It may be necessary to produce not only copies of ability to repay the principal and service the debt from the proceeds of the proposed new activity, but also to provide evidence that market potential has been realistically assessed, that materials, labor, equipment and facilities are, in fact, available at the time when it is required 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 many cases, a high degree of honesty and documentation will be needed.

There is another point which may well lead to formal project preparation, even for the expansion of existing enterprises, the government of governments in the economically underdeveloped nations, enterpriser are usually promoted to expand their operations, without reference to government authority and in many cases, the effects of plant expansion are considered to be regional or national balance. Such aspects of natural economic policy are in line with the development countries. This is usually not the case. An enterprise, for economic development, has limitations of foreign exchange, scarcity of skilled labor and management, and other important factors, frequently lead governments to impose controls on investment in enterprises of its source of trade or geographical location. The object is the establishment of a new industry or the expansion of an existing one. Conformity with national investment policy of 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. Many 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 feedback 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 may 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 home-fade 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 their own economic objectives that may be at variance with national policy and the national interest.

Personal responsibility for the preparation of industrial projects should continuously reevaluate the evidence they assemble and the conditions they develop. Project staff are in a different situation from those who work under more formal 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 ultimate purpose of project development work is the ultimate establishment of an industrial enterprise capable in terms of clearly defined objectives. At first point it becomes apparent that these purposes cannot be achieved, the justification for further effort and expenditure disappears. The means employed to intrinsic value, except perhaps an investment correctly evaluated re-examined in the light of experience generated by the process of securing returns, will also reveal that the project as originally conceived is inappropriate, but that in modified form may be feasible; objectives which competitive objectives can be achieved.

Since the project staff must be guided by the most intelligent and logical decisions in the light of relevant facts and their implications, it is desirable that they should possess a high degree of intellectual and emotional maturity. In commercial enterprise, the test is to select project personal who possess the qualities of enthusiasm and dedication, the degree of scepticism and the capacity to recommend the termination of projects. Those who have their own activities whenever possible, may find that the objectives of the project are not satisfactorily attained.

The total cost of an industrial project or developing country may greatly exceed the cost of a similar project elsewhere. It may be necessary to devote expensive effort to the assessment of future profitability and market potential, and to develop information that would be readily available in the test market. Distance from sources of equipment, building materials, technical assistance, power and other facilities will also add cost. Although not always apparent, the high cost of manpower and low labour productivity may make projects with which they are costs higher in developing countries, but they are also much more difficult to accept than in economically developed countries. Equipment, materials, access roads, worker accommodation and many other costly items may have to be allocated if the project for which they are acquired is then 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, if 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, a comprehensive survey proves to be a necessary second step, the scope card, hence, cost of the survey should not be designed to provide more information than will be needed when the results are due. Thus, it 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, but it may greatly increase the cost in carrying out the work in two or more stages. Here, as in many other cases, too much and too-deep-seated analysis and judgment can provide a sound basis for decision.

In the area of cost estimation, estimates are made, under the elements that must be examined in the preparation of industrial projects have been discussed in detail elsewhere. We pass now to the question of market demand, which, as we have seen, is one of the essential elements in the market of the firm and determined by an interaction of technical, political, and economic elements. Although the types of principal parties that will be involved in the production of these products may be the same across the world, these parties will differ in their respective technical and economic institutions and their objectives and hence be concerned with different social, social, and economic effects. Thus, even if the same parties are involved, their objectives may differ from country to country, or from region to region. There may be technical differences, but this will not be the case to the same extent that the parties to the credit of government aid and the variations in capital equipment involved. Estimates are made and economic planners would advise their customers' only in light of their own positions and do not normally share these costs with industrial plants, public utilities, or private hands.

We shall assume that the project elements that are of primary interest to the investor are in accordance with the market demand and that the preparation of the project can be adequately dealt with by the project preparation staff. We shall then consider the implications of market requirements of funding institutions and government agencies that may become involved in the project at a later stage. For we shall here consider the role of the project preparation staff in the area of primary interest to investors.

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. 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 products in developing countries have been designed on a scale that has proved too small to supply the market that their existence has stimulated. 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 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 resistance will inevitably be involved. Indeed it cannot be denied that these concerns will stimulate and direct the economic development of a nation can save little regard to the wishes of the individual. One must constantly seek to make his work harder, save more, and change his spending habits. An element frequent's overlooked in individual project preparation is the need to modularize the emergence of many different prospects or ratios that uncertain results may not be entirely controllable 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

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 a broadly 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. Assumptions that the technology it is proposed to employ is well tried and not in serious danger of early obsolescence so 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 a project's technical feasibility at the stage of its presentation 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 organisations 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 organisations 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 in respect of the project, but before the implementation of the project offer to conduct feasibility studies or project preliminary cost should be equally suspect. Very costly marine surveys may in fact be needed before a project can move forward, however, so there should be the responsibility of a government department with responsibilities for resource development and who should also undertake or commission marine surveys, at a cost borne by the government, to provide the necessary data for the project.
programmes to consider the economic impacts of the projects and prepare in more effective manner.

The appreciation of social costs and benefits is a method for which is based on a comparison presented with the assessment in the project documents of the explanatory information. Elements of the appreciation should be allocated in the context of social and government revenues and expenditures, associated with the increase in employment and income as well as the increase in economic revenues and expenditures, with an attempt to add a respective contribution of the project.
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 total expenditures provides a useful measure for comparing the proposed project with other projects. This information will also be of interest to potential financing institutions.

In a number of multi-sectoral projects in some developing countries and the hard covenant practice of exporting exchange incomes at an artificially high level is a difficult problem of these countries with estimating the foreign exchange effects. It is in the development phase. It is most important that the study be meaningful and resolved in context, to maintain a balanced and competent body of information for investment and foreign exchange policy formulation.

1.0.6 The project context

The project context of the region and development activities in which the project is intended to function. Much of the work will be done by the exercising the important role of international financial institutions in the development phase. The work should be meaningful and resolved in context, to maintain a balanced and competent body of information for investment and foreign exchange policy formulation.

Positive findings may be accompanied by proposals on how further to develop the project. The project may be accompanied by recommendations for a number of important development groups and countries in developing the project to a greater extent. It is a partnership between private sector and government.

Few contrasting views to those presented and making a positive impact on the economic situation of the region. The project may be accompanied by recommendations for a number of important development groups and countries in developing the project to a greater extent. It is a partnership between private sector and government.

The success of the operation of a project is determined by the extent to which it is understood and accepted by the community and the manner in which it is implemented. The project may be accompanied by recommendations for a number of important development groups and countries in developing the project to a greater extent. It is a partnership between private sector and government.
INRODUCTION

In the process of development of a project, the decision to proceed with the project is often based on preliminary feasibility studies. These studies are designed to assess the economic and technical viability of the project. The results of these studies are used to determine whether the project is worth pursuing and to identify any potential problems that may arise during the implementation phase.

The preliminary feasibility study is usually performed by a team of experts who have knowledge of the project's specific sector and who can analyse the economic, technical, and financial aspects of the project. The study will include a review of the project's market potential, the availability of resources, and the project's potential for profitability.

A feasibility study is usually performed in several stages. The first stage is the screening stage, in which the project is evaluated to determine whether it is worth proceeding with further analysis. The second stage is the detailed feasibility study stage, in which the project is evaluated in more detail to determine the project's technical and economic viability.

1. Administration and evaluation

This phase may be divided into two sub-phases: the administration and the evaluation phase. The administration phase involves the preparation of a report that outlines the project's objectives, the resources required, and the expected outcomes. The evaluation phase involves the assessment of the project's technical and economic viability.

2. Calculation

The calculation stage involves the determination of the project's financial viability. This stage will include the calculation of the project's costs, the calculation of the project's revenue, and the calculation of the project's profit. The profit will be compared to the costs to determine the project's profitability.

In conclusion, the preliminary feasibility study is an important tool in the decision-making process for a project. It is essential to perform a thorough feasibility study to ensure that the project is viable and to identify any potential problems that may arise during the implementation phase.
3. Administration

As in the administration 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 secretary 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 ensures 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 client obtains competitive quotations for machinery and sometimes helps direct negotiations with machinery suppliers, ensures that machinery which is ordered has PICIC's approval, obtains export permits for the client's establishment of credit terms. Banks are prepared by the bank itself and in others by commercial banks and receive shipping documents from suppliers and after checking them endorses them over to the client who then releases 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 the disbursement stage designed to ensure that funds are spent in accordance with the understanding between the borrower and the bank; and (b) long-term follow up after the fact 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 disbursement stage is only peripheral considered in the disbursement interest that follows.

II. Responsibility of the professional cadre of the development finance institutions for project disbursement and follow up

In a project the initial problem is that of bringing a proposal to the stage where it may be adequately evaluated. Someone must then be prepared to initiate the whole chain of development finance institutions in developing that project and in preparing its application for assistance. When there is an initial phase of potential clients into the situation 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 attached 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.

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 most industrialized countries serve those who make decisions on the allocation of finance. Financial analysts 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, there are reliable independent advisory consulting services to advise the allocation of finance.

Arthur Lewis' statement of a decade ago that 'lending money to inexperienced small business people without supervision is often equivalent to throwing it down the drain' correctly stated the need for client assistance to the follow-up stage.

II. Responsibility of the development finance institutions

Who is to have primary responsibility for providing such assistance to the borrowers? In any government agency the 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 the development finance institutions and the way in which members of the cadre allot their individual energies to their various tasks.

The shortage of project and the disbursement record of many early development finance institutions which extended credit without adequate evaluation or follow up have led us to experimentation with new institutions such as the Industrial Development Centre mentioned above. Those are charged with responsibility for developing projects, helping them to finance and ensuring that they progress on their execution.

In the 1970s, a number of early development finance institutions were established in Africa. These institutions were operated by the Ford Foundation, the governments of Nigeria, Ghana, and Tanzania, and the United Nations Industrial Development Organization. The International Bank for Reconstruction and Development (IBRD) and the World Bank are also involved in similar activities. These institutions have been charged with responsibility for developing projects, helping them to finance and ensuring that they progress.

In the United States, the Small Business Administration (SBA) and the Farm Credit Administration (FCA) have been involved in similar activities. These institutions have been charged with responsibility for developing projects, helping them to finance and ensuring that they progress.
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 rejecting a project. This authority should not be capable of being delegated to others. Therefore the institution's responsibilities to the governments, international sources and others will have to be avoided in it. It must and assign itself the project's value both to the country funds and thereafter until its interests are fulfilled. In effect, it should perform its own evaluation and follow-up. If these functions are to be performed by other institutions, there may be overlapping in effort and thus wasting of scarce professional resources. Because of this close relationship among the three phases of the development and evaluation stage of a project, a development finance institution must often also find itself thoroughly involved in the development of projects.

It follows that primary responsibility for the adjudication 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 supplied from a development finance institution, leaving behind a viable professional cadre capable of satisfying the institution's own requirements.

The above is only one part in the life of a project, mutually interwoven with the others. The reasons for establishing capable 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 cooperation 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 embed, restrictions governing future activities of the borrower as normally run between him and the finance institution. These are some of the 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 what 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 these costs are not desired by 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.

The policies of the international and bilateral external agencies have in some respects served to separate responsibility (most particularly in the development phase) from the source 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 prematurely promotional. It must set its sights somewhere in between." The industrial development...
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 a lack of balance in the evaluation of self-initiated projects. The development division of the Uganda Development Corporation (UDC), for example, was responsible both for evaluating client proposals and for initiating its own 'home-grown' projects. In other words, it would be interesting to see whether there is a connection between the regular evaluation flow and the evaluation by others.

A second problem is the allocation of the professional cadre's time between self-initiated and client-initiated projects. To a large extent, it is control of time that may be beyond the capacity of the development finance institution. The balance between self-initiated and client-initiated projects may not be as large as it is in some development banks. Where there is hope of building a stronger institution, the financial institution structure is sufficiently developed to support a proliferation of small businesses. The attitudes of borrowers in the more industrialized countries towards advice from their bankers suggest that good advice will eventually be accepted by the majority. Although it may not be received at the present time, although it may not be as widely distributed or had different sectoral specialties such as agriculture or small business.

3. Balance between cost consciousness and development determination

Some development finance institutions tend to be too conscious of cost, and therefore seek to earn the term 'development' in their title. On the other hand, they want to stand out from the crowd in their own projects, and outside projects. The question 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 would like to shift cadre resources from client projects to initiation. The departmental structure should not be such as to hinder such a shift.

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 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 suggest that good advice will eventually be accepted by the majority. Although it may not be received at the present time, although it may not be as widely distributed or had different sectoral specialties 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 Industrial Development Corporation of South Africa (IDC-SA) takes a different view in this regard. The related tasks of client development and the cadre at the reception point and operational means of permitting advice to suit different types in 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 rates, 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 next stage of 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 months has been expended so far.

At this point, if the investigation proceeds to a full investigation, a week's field investigation (twenty-one man-days) gets an equivalent amount for writing the investigation report, it's normally expected. Hence, a total of forty-four man-days may be involved. The cost at the end of the preliminary appraisal is therefore roughly 15 percent of the budgeted investigation cost, if the development 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 PhIC14 (Pakistan Industrial Credit and Investment Corporation), the preliminary appraisal spans the reception, initial appraisal and full appraisal phases. Its credit and general department receives applications and does some mechanical or formal screening. It also investigates the background of the applicant and the prospects of the project's producing a viable impact on the economy. The department's report is a one-page summary. It is reviewed, either by the general manager or sent to the applicant stating a brief reason. In order to keep other departments informed as to 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 PhIC.

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 PhIC'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 (TIB/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 of 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 IDCSA (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 positive recommendation.

The finance 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 positive recommendation. The finance 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 positive recommendation.

Sometimes it may be desirable to have a senior officer make the initial screening. On the basis of this 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 one point 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 cadre and therefore cut costs.

12 This project is not continued to develop bankers' the author heard about strong expressions among Nigerian money bankers in Lagos.


14 A copy of the report of 21st meeting of the Pakistan Industrial Credit and Investment Corporation, 1974 is on file.
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 entreprenuers. 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 wise 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.

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 expertise affect those within it. Apparently, getting the people involved more quickly, it stimulates a quicker manipulation of the data than is done with separate appraisals. The economist, the engineer and the financial analyst into professional development banks. It can be used under most administrative structures, as used by development finance institutions in providing departmental organizations. Finally, team appraisal minimizes several negative attributes inherent in separate departmental appraisal.

IDB-T: Industrial Development Bank of Turkey, IMDBI( Industrial Mining and Development Bank of Iran. PIRC: Pakistan Industrial Credit and Investment Corporation and IDB: Industrial Credit and Investment Corporation of Iraq, are similar in many respects. All are public owned with a relatively dominant ministry of finance. They are strongly supported by the development finance institutions of their own countries and tend to operate in an essentially large scale. Within the context of the development finance institution, they are largely comparable. Groups known as development finance companies in Europe, and the very best development finance companies in their countries, are subject to the very same financial and technical controls as of IDB-T and IMDBI are defined above.

(4) In IDB-T, a full appraisal is provided by three departments: financial, legal and economic research. We have seen that a first check was made by another department to ensure that the application material was in required form. A new project is then turned to the engineering department which studied both physical feasibility and profit potential. A departmental report is prepared. The file then goes to the economic department and the financial analysis department for separate investigations by each. The finance department then merged parts of the other two reports into its final report, which was sent to the finance committee. Hence the flow of the loan approval under team consecutive separate departmental approaches was as follows:

<table>
<thead>
<tr>
<th>Engineering department</th>
<th>Economic research department</th>
<th>Financial analysis department</th>
<th>Departmental review</th>
</tr>
</thead>
</table>

41
(b) A loan application in IDMBI 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:

![Diagram of departmental co-ordination]

(b) At IBR T, after a loan application had cleared initial preliminary appraisal hurdle, 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, although in fact he

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

![Diagram of operations department co-ordination]

As IBR T used the same team approach as IBM, that control the economics member, evidently due in part to its view that determination of long-term 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 there was cunning and prospectively a seller's market, what could be produced locally could be sold.

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 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 IDBM T and IBM T 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 PICUs'). The technical department has been merged with it. A joint financial-technical team prepare 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 IBM T 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 intrinsically 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.”

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 IDBI—five to six months. Although Engle's data were based on rough estimates by the management 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. Moreover, 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 reduced to the decision-making level, where it is more properly placed. Finally, the team approach would seem to minimize rivalry and misunderstanding among the three disciplines, thereby further encouraging professionalism in development lending.

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 believe it to be a protracted process. 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. In fact, 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 is and forward. IDBI gives potential clients a list of items 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, IDBI looks at this a basis for judging the status of interest accounting and information control systems within the client's company. Another method is to use different questionnaires for different sized projects. IDBI (International Bank for Reconstruction and Development) has a long questionnaire for industrial projects and also a shorter one for small industrial projects. The Industrial Finance Department of IDBI has three categories of forms—applicable to a different category of client—B or C, the Development Finance Organization of Greece (HEDN) has standard application forms for different loan purposes.

A different approach would be to encourage the client to submit initial, idealy a tentative, information on the basis of which the institution would then decide to submit a formal application. This would involve the institution developing data at an earlier stage. There would seem to be a third level of data, which is important, but not as crucial to provide in principle, the data base. This may be taken into consideration when the bank has been given a list of potential clients. If the bank has a record of the client's previous bank usage, it should be able to evaluate the potential client's needs as part of its corporate records and determine that the latter category.

The ultimate solution lies in building up a confidence of the business and government in the development finance institution by the client. It is only when the client is convinced that the presentation of its proposal, a sound application, will be rewarded with the granting of finance, it is more willing to disclose the ultimate task of compiling the information requested.
We know 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 success or failure by the decision-makers. Our empirical knowledge is 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 prejudice or short-sightedness of politicians within the country, the presence of a 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 not 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 by those responsible for evaluating a project to a body on a level below that of a board of directors. The decision by the board of directors or members to which it has delegated authority, if and where, where the funds selected are from an external agency, approval from that agency prior to final commitment to the borrower. This pattern occurs with the size of the institution and the depth of its organization. In the case of several development organisations established by the Commonwealth Development Corporation (CDC), for example, the pattern is to keep a very small staff, and those making technical selections from the other as regards. Hence, an elaborate decision process does not exist.

In contrast, the selection process of the World Bank is effective.

The most notable characteristic of this pattern is that decision-making is on the surface, to be much hidden. The evaluation process is the key. The evaluation process is an evaluative one, normally goes to a committee. The committee consists of several managers, typically the general manager, his deputy and department heads. It considers the project report and submits to the board of directors. In the project approval committee consists of the general manager, deputy general manager and other members. In the evaluation department office in charge of economic research, chief economist, chief of operations chief of accounting, finance and planning.

In the CDC, the special committee is made up of the general manager, his deputy general manager and heads of the economic research and finance departments.

In the CDC, the investigations committee is composed of officers immediately below the top managerial level as represented by the general manager. The decision is made by the board, the president and managers. As the CDC is among the oldest development finance institutions, this pattern suggests that, as a development finance institution matures, the particular committee function may step down one or more levels of management. In contrast, Ghana’s young NIB (National Investment Bank) also an executive committee on 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. This 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 assuming responsibility for the selection process to a single officer.

The concept of a loan officer who combines both the evaluation and the selection functions is infrequently seen in development banking practice. The evaluation officer, a professional development banker, 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 will tend to regard members of the professional cadre as engineers, accountants, lawyers, economists, rather than as development bankers. In reality, many of those men may be undergoing a subtle transition similar to that noted among BBC staff members.

"All these three types can become the loan officer's expert, and hence, more work in very close contact to the end that they have been working together for a certain number of years. A new staff is produced. A kind of a prototype investigator in the World Bank and in the International Development Association."
The second step would involve placing more responsibility at the selection stage in the hands of individuals: an 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, IDAC SA International Development Corporation of South Africa launched designs and development of the specialized background at the departmental levels. The roles of technical manager, financial manager and marketing manager were all changed simply to manager. The objective was that each staff be responsible both by the IDAC and its clients, an. 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 deputy to the general managers in IDAC, ITT and ITT in similar moves to widen the management levels which span the specialized fields. IDAC has two deputy general managers. ITT 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 it was created and the post of general manager of the Egyptian Industrial Development Bank earlier in 1980). It has one deputy general manager. This experience suggests that the evolution of the development finance institution manager would be towards a greater overlapping of the three specialties in the person who will either have technical competence and supervisory responsibility bridging more than one field in which he was trained.

At lower levels of the professional staff, a few similar experiments are taking place. IDAC has had in the past a staff engineer who also had a business administration degree working in both financial analysis and engineering departments. The deputy general manager of PTTC was thinking in this same vein when he expressed the hope that PTTC engineers would someday be trained as financial analysts. Engineering, however, is most likely to go for such multiple-discipline competence. Wherever it has noted that it is probably easier to train people possessing a technical background with some knowledge of economics to be good engineering planners than it is to provide economists with the necessary technical information necessary. Although the quote pertains to programming the point applies as well to project evaluation.

Tighty progression towards these goals would facilitate the establishment of professional standards to those within such a new institutional framework. The result would inevitably be a higher more capable cadre. Such a transformation would also bring about changes in the procedures and organization of development finance institutions. The present problem is whether to lay behind the readiness of the staff to assume wider and deeper responsibilities and to push the concept too fast.
A SIMPLIFIED APPROACH TO INVESTMENT EVALUATION USED BY PRIVATE ENTERPRISES

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 proposals 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 investments 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 supplemented by some of the other criteria we discuss later.

The three most commonly used yardsticks of profitability are the pay back or repayment 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 proposed new investment to repay the total capital invested in the new project. It answers the question, How long before the cash return from this project returns the original cost? For example, a new machine is installed at a cost of $10,000. If the net cash return 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 worthwhile investments because it is measurable and many people have how to compute it and can be employed with many kinds of projects, whether large or small. In addition, pay back has some other advantages: It requires no estimates or assumptions on the future, while the income varies with the economic revenue or price history. It also gives only a minimum profitability by preventing investments that may lead to long pay back periods.

However, the method has some important limitations. A manager in the fast-moving chemical industry, for example, may accept a proposal that has a pay back period of 3 years simply to get back his investment in one or two years. If the plan’s earnings are declining, the pay back period will shorten after the pay back period. Hence the manager may have no assurance that the pay back period is a true measure of pay back period period. If the project proposals are ranked on the basis of pay back period only, the projects will be ranked with the least preferable at the head because the second actually more promising is not long run.

A second shortcoming of the pay back period is that it is unrelated to the risk of the project. Suppose the project is identical to an existing project in all respects except that the new project is larger. If the new project is 100% more successful than the old project, the pay back period will be the same for both projects. However, the pay back period method does not consider the magnitude of a project or the size of the capital utilized, although the long-term earnings from such investments may be very high. Yet such innovations often turn out to be the most profitable.

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 invested.

Average return on investment does not, in itself, account for the time pattern of income, whether the income is evenly distributed over time or is heavy in the early or later years. Using both the pay back and average return on investment methods together alleviates this deficiency. However, a question still remains as to whether to carry the more weight pay back or profit when one investment to be compared with another investment with a smaller pay back but a larger 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 may be from several integers to as high as 50%. But if you could use the correct method. First, the average lifetime income figure should be used in computing the true return. Next, the average income figure should be expressed before depreciation. The answer to this question can halve or double the result. It should be before other income losses should be added on in straight line or compound interest.

Based on the average return on investment method, one decides what investment he or she wants to employ. In the same way, in the same industry, in the same market, at the same time that the market is new in the same time and the same place, the manager will know whether the investment should be used. For example, if the market starts to expand, the manager may know whether to use an investment that has recently been in the market or an old investment, or whether to invest in the new market, or somewhere else.

This method is also one of the factors on which a small investor’s investment is based. Once the investor knows the average return, he can decide whether to invest in the project or not. This method can be used to determine whether the investor should invest in the project or not. If the investor is using the method to determine whether the investor should invest in the project or not, the investor may decide whether the investor should invest in the project or not.
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 cash flows from the project may be reinvested and continue to earn. It also makes an assumption regarding the rate of return on the money invested as well as earnings above the payback amount. A major advantage of the discounted cash flow method, therefore, is that it correctly takes account of differences among periods in the time value 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 at the same amount now. For the same reason that current earnings are worth more than future earnings, the discounting formula takes this into account by capitalizing into the firm correctly.

One of the disadvantages of the discounted cash flow method is that 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 threshold would be rejected under this criterion. The computation involves discounting cash inflows and outflows associated with the adoption of the project to the present value at the specified rate of interest. If the present value exceeds zero, the project may generate a return in excess of minimum required by the firm. Financial management.

We should note the limitations of this method:

- It requires a more-precise statement of investment costs and revenues as well as the statement of market capitalization on the part of the firm.
- It does not consider the value of the alternative investment that the proposed investment replaces, making it impossible to evaluate the magnitude of the project.
- It evaluates the project economically, assuming the accuracy of estimates and the validity of the assumptions.

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 for us to 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 $0.8 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, the 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 value. 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 additional 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 are not 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 show the conceived indirectly enough to encompass intangible and when unquantifiable—benefits. When these have to be assessed from 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 immeasurable benefits, the burden of proof clearly rests on the imponderables.

Some important principles of measurement emerge from the 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.

1) 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 need to provide people with work in an underdeveloped area. Investors with large amounts of funds readily available can take greater risks than 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 adaptable to both the long-range plan discussed above and the elements that go into this plan and the policies that emerge from it. It is important to determine these criteria, which should be designed to ensure attainment of the plan's objective.

A convenient way to attack this problem is: investment proposal evaluation is to set objective standards of common acceptability. With such guidelines, unacceptable proposals can be screened out immediately and if all proposed investment projects should prove unacceptable, a search can be made specifically for new proposals.

A company's cost of capital is the rate the company has to pay for money. It reflects the total market's appraisal of the company's past and present performance as compared to other opportunities open to investors. Just as the cost of capital on projects with rates of return that are lower than its cost of capital is terminal, then it would appear that the market loses confidence in the company and ultimately it becomes more difficult to look for projects for the company to undertake. The increased cost of capital is thus a good minimum rate to use in evaluating projects.

Once cost of capital must be used as a standard for new investment decisions, but what will money costs in the future? This 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, imperiled 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 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 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. The position will be taken in this paper that 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 net profit in each period, representing the gap between the aggregate value of the outputs and the inputs of that period. To convert this into one profitability figure, we need still further information, namely, an inter-temporal comparison. Much of the controversy of recent years on market allocation has been concerned 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 \( R_1, R_2, \ldots, R_n \) represent the flow of planned inputs in the period \( 1, 2, \ldots, n \), respectively. We have another time series for each type of input \( 1, 2, \ldots, r \) where there are \( r \) types of inputs, namely, when there are \( k \) outputs, there are \( k \) number of time series of the type \( O_{11}, O_{12}, \ldots, O_{1i}, \ldots, O_{ki} \) representing the flow of output type \( i \) in period \( 1, 2, \ldots, m \) with \( j = 1, 2, \ldots, k \). In this model, we consider \( k \) 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 the gaps by putting zero values to the relevant inputs or outputs, when as originally defined, they are some inputs and no outputs for a while and later on there might be some inputs, and no outputs in a number of periods. We shall thus attach a zero value to every output except those taken over the entire period.

If the prices of input in period \( 1, 2, \ldots, n \) be given by the sequence of prices \( a_{1}, a_{2}, \ldots, a_{n} \) the physical time series of inputs for the period be converted into one series of aggregate \( R`_{1}, R`_{2}, \ldots, R`_{n} \) for each period, at which the \( n \)th element looks as follows

\[ R`_{i} = \sum_{j=1}^{k} a_{j} \cdot O_{ij} \]

We have such a time series of the form

\[ R`_{i} \]

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1 See in particular Lerner and Taylor (20) E. Lerner (21).
Similarly, given the prices of the outputs for each period, \(v_0, v_1, \ldots, v_n\), representing the series of the typical output \(v_i\), we have a time series of aggregate value of returns derived in an identical manner \(f_0, f_1, \ldots, f_n\). 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 \( \pi_0, \pi_1, \ldots, \pi_n \).

We have spelled this out only for the sake of clarity. Once, however, we get the series of net profits, which we shall refer to be the vector \( \pi \), we have a data 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 \(r\). The present value in period \(0\) of the series \( \pi \) at the rate of interest \(r\) is given by:

\[
V = \sum_{i=0}^{n} \frac{\pi_i}{(1+r)^i}
\]

(1)

This is the standard formula for obtaining the discounted value, and need not be elaborated here. Given a rate of interest \(r\), therefore, all the time series of the type \( \pi \) can be converted into a present value of the type \( V_0 = \sum_{i=0}^{n} \frac{\pi_i}{(1+r)^i} \), 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 one project \( P \) and use an interest rate \(q\), and calculate \( P_{\pi}=\sum_{i=0}^{n} \frac{\pi_i}{(1+q)^i} \), as given by (2). If this present value is positive, value \(q\) is a lower interest rate, and if the present value is negative, value \(q\) is a higher interest rate. Through these steps, we can find out the rate of interest, which makes the present value of the series \(\pi\) to be exactly zero. The rate of interest \(q\), at which this happens, is defined as the internal rate of return of \( \pi \).

\[
P_{\pi} = 0
\]

(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 discontinuous, or non-classical problems. The internal rate of return also is a discussed later in the text.

is, in general, not a serious objection to the internal return rate. However, the question of uniqueness is an 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, 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 \(1 < k \leq n\), \(X_k < 0\), and \(k > n\), \(X_k > 0\). 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.

In my judgment, 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 one means the market rate, assuming the market to be perfect, which makes 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 commercial evaluation is not the
internal rate of return but the present value. This point has of course been much discussed in the literature, 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 enterprise 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 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 state 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 "profitability" are used in economics in somewhat different senses, we may perhaps be making analytical distinctions by going further into the analysis of national economic profitability.

The most widely used notion of optimality in economics is one basically similar to the so-called "Pareto optimality". A Pareto improvement indicates a situational change where some people are at least one person's gain and nobody loses. Each individual is assumed to be the relevant judge of his own welfare, so that the Pareto 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 Pareto improvements are possible starting from such a situation, but it is obvious that this optimality is a very weak one. It can, for example, be achieved even when some people are suffering merely from hunger while others are excessively rich so long as the misery of the poor cannot be alleviated by disturbing the well-being of the rich. Indeed, 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 must obviously be necessary for welfare maximization, although we may not find it sufficient. To express 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 sufficient condition. We shall not enter 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 certain absence of external effects or of saturation of wants, every competitive equilibrium is a Pareto optimal solution. So that if projects are evaluated by the

\[ P \left( q_i, \{ N_k \} \right) = \sum_{i=1}^{n} \frac{V_i}{1 + \bar{i}_1} - \frac{1 + \bar{i}_2}{1 + \bar{i}_3} \quad (24) \]

\[ 1 \]


\[ \text{The opposite statement that Pareto optimality is a competitive equilibrium is not true. The optimality of projects requires the further assumption that individual capital projects are divisible.} \]

\[ \text{Such an assumption is not realistic.} \]

\[ \text{See Kalecki [18] Weier and Kuh [11].} \]

5
1. The assumptions are perfect competition, and is concen trated  on the product of the economy that are relevant to the problem of market price and its determination. Indeed, this result is not the most that the members of the present generation identify their interests with those of their heirs, so that the future generations are also represented in the current market operations of both. In some sense this is undoubtedly true. The question however, is whether these future welfare interests are adequately represented by the market process. This will be an important consideration for us to take up in the context of correcting market prices.

2. Indeed, so far we have not raised any objection to the goal of achieving only Pareto optimality and nothing more. Clearly this is a very long-term goal. We are interested in the distributional questions even if we cannot always formulate this consideration very precisely. The market attaches the 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.

3. Thus commercial vs. national profitability

4. Essentially the problem of finding a set of general criteria for industrial project decisions is one that 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 how ever that such a grand general problem only has optimum solutions which in practice are impossible to determine. An alternative is to give up the exercise of finding a rule and follow some heuristic rules of thumb. A perspective on these problems is provided below in the context of the question of how to gain an understanding of the process.

5. One approach is to claim that the problem of social optimality invariably involves value judgments and that since economists are not permitted to indulge in this luxury the best they can do is to take up some objective criteria, such as the functional feasibility of the project. The moment an economist claims to make value judgments, he is perceived as doing an immoral act. This is usually argued that economists should make only analytical points rather than policy recommendations. The fact is however that economists do have to make value judgments even if the decision is made in the absence of such judgments, the debate over them is actually involved in project evaluation and the allocation of the resources. In this sense a decision is essentially immoral if someone can put forward an argument that is usually observed varying from commercial benefi t to national cost.
bility to measuring the specific gravity of the
material or measuring the number of individually
measured men on the project site and if we want to
learn more on one of these we have to do so on grounds
other than observation. After all what we are concerned
with is how to use some criteria that correspond
to our view of economic or social goodness and to
to expect that we can do this without making some
serious value judgements in exactly. There is no
reason of course why the economist may not
the judgment should be given a special place and
this is indeed a valid objection made to point. The
economists job is however to represent his
judgement as fairly as he can the values that are generally held
in the community in question and while this may be
difficult to do precisely the impression received
here is probably no greater than that involved in a
variety of other exercises that the economist is
continuously 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
acceptability.

A second approach closely connected with the
one is to point out that the hope of getting a
social welfare function based on the votes of the
members of the community is very weak for these
criteria cannot really be combined into a consistent
set of social welfare functions by any of these in any
intended to point out that the problem of some
reason making is exceedingly complex. The point
is well taken although it is difficult to see with
exact policy implications this in regard to social
welfare. However the point is made in an incorrect
more a form claiming that there is something in
recently wrong in expecting the analysis made
consistent. Much of this confusion and the
Arrow's well known impossibility theorem is
ought itself to be obvious to put at the
problem in question. The utility of combining
individual values into social welfare might not
be obvious to many. In particular Arrow's theorem follows from
as a theorem following a
suggestion of Danielson 13 that even if the
criteria are single ranked transitive but
consistent in a consistent manner and not
changing the community by certain policies
immediately in a perfect democratic form. This
will can be further extended into a more
general the sense of the who cannot define
the community can be altogether consistent.
We do not propose here to go further into this
question and only want to point out that there can
be a social welfare function that is perfectly consistent
but necessarily violate the usual meaning of

We have claimed so far that the only ground
for submission of such use in such cases is
that there are other factors social welfare
measured in certain circumstances a perfect score
such as utilization of the available resources in a benevolent manner. We have
...
the market wage rate. Equation (5) expresses the relevant concept of cost in a manner that can be directly related to observed magnitudes. To and T1, and an explicit value judgment can be incidentally implicit in the choice of A. But the link between the least product, namely, the choice of the social rate of discount, and the present one, namely, the choice of the social cost of labor is established both by the choice of the rate of saving as taken to be too low or not.

C. STRATEGY OF INDUSTRIAL DEVELOPMENT

CONCLUDING REMARKS

The approach used in this paper has been one of detailed calculations and benefits from a social point of view. We have avoided the different types of correlations needed to move from an estimate of commercial profitability to one of national gains. To resolve the problem satisfactorily were we to undertake new, detailed calculations making use of observations as well as explicit judgments.

A general reference should however be made to the approaches that have shown general applicability and have shown balanced growth patterns for example choosing balanced growth or selecting quick multipliers of going out for bids. We refer to the discussion of these general principles and not a specific concern for specific techniques. Some are indeed of greater concern for economic planning and with certain strategic underpinnings. For example some of these indicators have been used to describe the principal industries which are in the primary concern of the discussion of the national cost of growing the rate of saving from the figure given in the manner of discussion by utilizing the employment. The employment growth reflects the nature of investment between different projects and that which directly or indirectly reduces the most beneficial concern outlined in the paper.

However, while these simple principles are often quite right, the complex reality is such that not for the benefits of mixture of factors which are not selected on the basis of national goals. The differences between these industries are one of the main concerns of thinking of the national cost of growing the rate of saving from the figure given in the manner of discussion is in the employment. The employment growth reflects the nature of investment between different projects and that which directly or indirectly reduces the most beneficial concern outlined in the paper.

An alternative way in which to think about the black box approach is to think about the various effects which are not directly related. A key example is the various policies that have been adopted to influence the employment. The employment growth reflects the nature of investment between different projects and that which directly or indirectly reduces the most beneficial concern outlined in the paper.

I. SAVINGS

The sky was filled with smoke and hoisting equipment. A great length of machine belching smoke and reeling like an endless velvet. Smoke 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 to a quarry several miles away. Who asked the engineers in charge, but they did not draw the huge reservoirs of available hidden labor to replace some of the machinery. They could also have saved some electricity which was so short it was holding up the production of the plant in the area. The usual answer was that the dam site was too far away for cases of people to work and also a high lateness in nature required a lot of mechanical handling. A sure and slow, however, that there was plenteous water to many more people than were mentioned in the essential point which emerged in the course of this conversation was that these projects did not want thousands of primitive people using the, now, once, very saving driving all over the area. They would be out of control they were untrained in any way, and everything would be lost in the end.

Reference

Taking the last two alternatives the most broad, in terms that the air pollution affects both for a specified amount of time, and it was enough that the cost of the capital stock of the 1906, when the existing machines required, was not the amount needed in the background. The fact that the amount had to be paid by the company on the amount of the cost savings of the total amount had to be fully and increasing the working out for being more or less efficient, it would not put it into production, which although administratively very easy, is not found to be fully and increasing accurately and it is not seen to be cost benefit. The total amount had to be paid for the cost of the capital stock, and it is not seen to be cost benefit. The total amount had to be paid for the cost of the capital stock, and it is not seen to be cost benefit. The total amount had to be paid for the cost of the capital stock, and it is not seen to be cost benefit. The total amount had to be paid for the cost of the capital stock, and it is not seen to be cost benefit.
the comparative economic advantage which has been claimed for it.\(^*\)

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 straight forward 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. Feaver

IV. Problems of Commercial and National Profitability

...
imum 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 at 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 1945 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 fibre 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>
<thead>
<tr>
<th>Type of enterprise</th>
<th>Number of enterprises</th>
<th>Production capacity of an enterprise</th>
<th>Relative labour consuming characteristics of production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B: 1,000 units</td>
<td>No. 1</td>
</tr>
<tr>
<td>A</td>
<td>5</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>C</td>
<td>40</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>D</td>
<td>40</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>60</td>
<td>240</td>
</tr>
</tbody>
</table>

Table 1: Production capacity of enterprises of A-E type.

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:

\[ 5 \times 100 + 3 \times 400 + 40 \times 20 + 9 \times 200 + 2 \times 600 = 6,900 \text{ thousand units.} \]

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.

<table>
<thead>
<tr>
<th>Article No. 1</th>
<th>Type of enterprise</th>
<th>Number of enterprises</th>
<th>Total output per thousand units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>5</td>
<td>600</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>3</td>
<td>400</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>40</td>
<td>800</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>9</td>
<td>1,500</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>2</td>
<td>600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article No. 2</th>
<th>Type of enterprise</th>
<th>Number of enterprises</th>
<th>Total output per thousand units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>3</td>
<td>400</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>7</td>
<td>400</td>
</tr>
</tbody>
</table>

Total 2,900 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 greatest part of the total costs of transportation. We must also take into account additional factors, such as restrictions resulting from the 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 country-wide scale. Three factors were involved: producers of round timber and saw timber (37 timber organizations); 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 consumption, administrative centres of ninety-eight main economic regions of the country (Leningrad, Kharkov, Stalingrad and others) were taken, as well as the junctions of the coal basins (Debaltseno for the Don basin, Usjat for the Kuznetsk basin, Ustovaya for the regions near Moscow). The calculations were carried out in three forms: for the minimum production (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 main object depends on many factors, that is why these problems cannot be resolved by the usual methods of mathematical analysis (calculation of 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 enterprises 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), 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 a machine-tool (units) where various articles (products) are produced. If on the kth machine-tool (if \( k \geq 3 \), then machine-tool \( X \), if \( k = 1 \) the article is produced, then the quantity of the articles produced during the time of the machine-tool operation is expressed as \( a_{ki} \) units (if on the kth machine-tool \( k \)th article cannot be produced, then the corresponding \( a_{ki} = 0 \)).

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

Let \( h_{ik} \) designate the needed portion of time for the production of \( k \)th article on the \( i \)th machine-tool (i.e. part of the total time of the machine-tool).

It is known that the quantities \( h_{ik} \) are positive \( h_{ik} > 0 \) and the sum of all quantities \( h_{ik} \) under the change of \( k \) from 1 up to \( m \) is equal to 1, which follows from the very determination of the quantity \( h_{ik} \). Using the sign \( \sum \) for summation designations, we can write this dependence in the following form:

\[
\sum_{k=1}^{m} h_{ik} = 1
\]

From the determination given above for the values \( a_{ik} \) and \( h_{ik} \) it follows that the products \( a_{ik} h_{ik} \) correspond 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

\[
z_k = \sum_{i=1}^{n} a_{ik} h_{ik}
\]
The conditions of article sets under the above-mentioned designations will be as follows:

\[ Z_1 \leq Z_2 \leq \ldots \leq Z_m \]

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

1. Value \( h_{k,1} \) should be chosen so that the quantity \( Z = Z_1 = Z_2 = \ldots = Z_m = \sum a_{ik} h_{ik} \) be maximum.

2. \( \sum h_{ik} = 1 \) (\( i = 1, 2, \ldots, m \))

3. The proportions of the productivity of three types of machine-tools at the production output of two types are given (see table 3).

<table>
<thead>
<tr>
<th>Machine-tool type</th>
<th>Quantity of machine tools</th>
<th>Of our machine-tool</th>
<th>Of all machine tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>30</td>
<td>80</td>
</tr>
</tbody>
</table>

* 1. Lathe, turret lathe, automatics and others.

It is necessary to establish the optimum programme of machine-tool operation (production distribution) under the condition of production in sets, i.e., 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>
<thead>
<tr>
<th>Article type</th>
<th>Number of machine-tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_1</td>
<td>3</td>
</tr>
<tr>
<td>N_2</td>
<td>3</td>
</tr>
</tbody>
</table>

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

1. \( h_{i,1} > 0 \), \( h_{i,2} > 0 \),
2. \( h_{i,1} + h_{i,2} = 1 \),
3. \( \Sigma a_{ik} h_{ik} \geq \Sigma a_{ik} \),

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

Let us designate the ratio \( a_{i,1} / a_{i,2} = 1 \). The value 1 characterizes the labour-consuming factor of the production on the \( i \)-th machine-tool of article \( N_2 \) in relation to article \( N_1 \).

Let ratios 1, 1; and so on always increase, i.e., 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 \( h_{1,1} = 1 \), \( h_{1,2} = 0 \), and on the last \( h_{n,1} = 0 \), \( h_{n,2} = 1 \).

Let the transition from article \( N_1 \) to article \( N_2 \) be performed on \( N_1 \) machine-tool.

This condition can be expressed in the following way:

\[ \Sigma a_{i,1} < \Sigma a_{i,2} \]

so that to make one article on \( S \) 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 1 up to \( S - 1 \) and

\[ h_{n,1} = 0; h_{n,2} = 1 \]

for \( i = S \) up to \( n \).

The values of \( h_{i,1} \) and \( h_{i,2} \) are found from the conditions:

\[ h_{i,1} + h_{i,2} = 1 \]

and

\[ \Sigma a_{i,1} + h_{i,1} \cdot a_{i,1} = \Sigma a_{i,2} + h_{i,2} \cdot a_{i,2} \]

Use these ratios to solve an example from table 4. Ratios 1 (coefficients of a labour-consuming nature) will be equal to: \( 60 \) \( 30 \) \( 90 \) \( 90 \) \( 90 \) \( 24 \)

Arrange values 1 in increasing order:

\[ 10^2 < 2 < 24 \]

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

\[ a_{1,1} = 60; a_{1,2} = 30; a_{2,1} = 30; a_{2,2} = 60; a_{3,1} = 90; a_{3,2} = 80. \]

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

\[ \Sigma a_{i,1} = a_{1,1} + a_{1,2} = 60 + a_{1,2} + a_{2,1} = 140 \]

Let the transition from article \( N_1 \) to article \( N_2 \) be performed on \( S \) machine-tool. It is necessary to establish the optimum programme of machine-tool operation (production distribution) under the condition of production in sets.
\[ \sum_{i=1}^{n} a_{i1} = a_{11} + a_{21} = 00 < \sum_{i=1}^{n} a_{i2} = a_{12} = 80 \]

Consequently:

\[ h_{11} = 1; \quad h_{12} = 0; \quad h_{31} = 0; \quad h_{32} = 1. \]

To find \( h_{21} \) and \( h_{22} \), use the equations:

\[ h_{21} + h_{22} = 1 \]
\[ 60 + 30h_{21} = 80 + 60h_{22} \]

whence:

\[ 60 + 30h_{21} = 80 + 60h_{22} = 80; \quad h_{21} = 2; \quad h_{22} = 0 \]

The results of this solution are shown in Table 5.

**Table 5. Optimum Distribution of Production Output in Machine-Tools**

<table>
<thead>
<tr>
<th>Machine tool type</th>
<th>Production ( N_1 )</th>
<th>Production ( N_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Total number of sets</td>
<td>( N_0 )</td>
<td>( N_0 )</td>
</tr>
</tbody>
</table>

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 1936 by the Soviet mathematician L. V. Kantorovich,\(^1\) together with the simplex method and the transport (distribution) method described below, becomes more and more applicable.

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\(^1\) 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 \( i, \) corresponding to the value of the needed \( X \) is determined.

In fact, if this ratio equal to

\[ \frac{a_{i1}}{a_{i2}} = \frac{\lambda_1}{\lambda_2} \]

is known (the new ratio of values \( \lambda \) is introduced to make the following considerations more convenient), further, the values \( \lambda_1, \lambda_2, \ldots \) will be called decisive factors, the solution will be found for all values \( i \), for which

\[ \frac{a_{i1}}{a_{i2}} < \frac{\lambda_1}{\lambda_2}; \quad h_{i1} = 1; \quad h_{i2} = 0. \]

For the values \( i \), where \( \frac{a_{i1}}{a_{i2}} = \frac{\lambda_1}{\lambda_2} \), \( h_{i1} = 1; \quad h_{i2} = 0 \). Finally, for the values \( i \) at which \( \frac{a_{i1}}{a_{i2}} \) \( \lambda_1, \lambda_2, \ldots \) the corresponding \( h_{i1, h_{i2}} \) must be found from the equation

\[ \sum_{i=1}^{m} a_{i1} h_{i1} - \sum_{i=1}^{m} a_{i2} h_{i2} = 0 \]

In the above example, this relation was established for machine-tools \( i \) (see Table 5):

\[ \lambda_1 = 2; \quad \lambda_2 = 1 \]

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

It is necessary to find numbers \( h_{i1} \) \( i = 1, 2, \ldots, m \) from the following requirements:

1. \( h_{i1} \geq 0 \)
2. \[ \sum_{i=1}^{m} h_{i1} = 1 + 12, \ldots, m \]
3. \( Z = Z_1 + Z_2 + \ldots + Z_m \) is maximum.

Let us change condition 3 for the following:

\[ Z' = \sum_{i=1}^{m} Z_i - Z_m \]

and the value \( Z' \) must have the maximum possible quantity. In reality, this change of condition 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 \( Z_i \), let this least value \( Z_m \) be from \( Z_1, Z_2, \ldots, Z_m \), our task is to make value \( Z' \) the highest possible.

As a result of the transformation, the value of the problem is greatly simplified owing to the fact that, instead of taking one quantity of \( h_{i1} \), 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 in the 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: \( A_1, A_2, A_m \), and not all values \( A \) are equal to zero, possessing the following property.

If for each given one considers products \( A_i h_{ik} \), and denotes through \( t \), the values of the largest of these products, then taking \( h_{ik} \) equal to zero for which the corresponding product is not maximum, \( A_i A_k < t \). Again, \( h_{ik} \) can be obtained from the equations:

\[ 1 \ h_{ik} = 0 \]
\[ 2 \ \sum h_{ik} = 1 \]
\[ 3 \ \sum h_{ik} = Z \]

Thus the problem consists of determining the decisive factors.

This solution can be accelerated through "ranging" successive approximations. Thus, if instead of the values of decisive factors one takes random numbers,

\[ A_{10}, A_{20}, \ldots, A_{m0} \]

then it is possible to solve the problem as though the decisive factors were unknown, namely: compare products \( A_i A_k \) and make those \( h_{ik} \) 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 data quantities of this value up to the condition mentioned.

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

\[ Z = \sum h_{ik} A_{ik} \]

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

Excavators 1, 2 and 3 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, Tons/Hour

<table>
<thead>
<tr>
<th>Section</th>
<th>Excavator 1</th>
<th>Excavator 2</th>
<th>Excavator 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>105</td>
<td>117</td>
<td>114</td>
</tr>
<tr>
<td>II</td>
<td>56</td>
<td>60</td>
<td>58</td>
</tr>
<tr>
<td>III</td>
<td>56</td>
<td>83</td>
<td>53</td>
</tr>
</tbody>
</table>

To find the minimum duration of operation at which the given level of production is ensured, it is enough to find the distribution of the 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 \( a_{ik} \) of Excavators in Different Sections (10), Tons/Hour

<table>
<thead>
<tr>
<th>( i )</th>
<th>( k )</th>
<th>( a_{ik} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>105</td>
<td>107</td>
</tr>
<tr>
<td>II</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td>III</td>
<td>56</td>
<td>83</td>
</tr>
</tbody>
</table>

It has been found in practice that, as original meanings of \( A_{ik} \), it is rational to take values inversely proportional to the values of sums \( 2 h_{ik} \).

Let \( A_{ik} = 1000 \)

\[ i.e. A_{ik} = \frac{1000}{276} = 3.62; A_{ik} = \frac{1000}{160} = 6.25 \]

Then \( a_{ik} A_{ik} = 105 \times 3.62 = 381 \) and so on. Let us write out all the corresponding values \( a_{ik} A_{ik} \) (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

<table>
<thead>
<tr>
<th>( A_{ik} )</th>
<th>( a_{ik} )</th>
<th>( A_{ik} )</th>
<th>( a_{ik} )</th>
<th>( Z )</th>
</tr>
</thead>
<tbody>
<tr>
<td>381</td>
<td>308</td>
<td>231</td>
<td>105</td>
<td>107</td>
</tr>
<tr>
<td>340</td>
<td>412</td>
<td>237</td>
<td>105</td>
<td>60</td>
</tr>
<tr>
<td>292</td>
<td>432</td>
<td>276</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>381</td>
<td>308</td>
<td>231</td>
<td>105</td>
<td>107</td>
</tr>
<tr>
<td>365</td>
<td>412</td>
<td>249</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>292</td>
<td>432</td>
<td>276</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>365</td>
<td>372</td>
<td>222</td>
<td>105 ( \times 0.67 )</td>
<td>107</td>
</tr>
<tr>
<td>292</td>
<td>432</td>
<td>249</td>
<td>56 ( \times 0.33 )</td>
<td>56</td>
</tr>
<tr>
<td>292</td>
<td>432</td>
<td>276</td>
<td>56</td>
<td>83</td>
</tr>
</tbody>
</table>

92
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 202.

For these maximum values, take the value $h_i$ for the rest $h_j$.

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

The sums of these values give values $Z_k$ for the zero approximation $Z_k = 118^*$. $Z_k$ is shown in table 9.

By comparing these data we see that the value $Z_k$ is low, and for its increase it is necessary to increase the value $s_{ik}$ arbitrarily chosen. Let us consider, then, the second column of table 8 (numbers 368, 412, 432).

To "pull" the value closest to the maximum (the closest to 412 is 412), it is necessary to multiply it by a correction factor $A_k = 368 = 412 - 368$. (values $\lambda_k$ refer to the zero approximation, $\lambda_i$ to the first one, and so on).

A way of reducing the value $s_{ik}$ is the following: $A_k = \lambda_k = 368$, 381 - 0.058, 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 (368).

Since the value of the second line (368, 412 and 249) and of the third line (292, 412 and 276) remain unchanged, assume correction factors for $s_{ik}$ and $s_{ik}$ 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, $h_i = 1$, for all other values $h_j = 0$), for equal maximum values (368 and 432) one must again solve corresponding systems of linear equations:

$$\begin{align*}
   & h_{11} + h_{21} = 1 \\
   & h_{12} + h_{22} = 1 \\
   & Z_1 = 105h_{11} + 56h_{12} + 66h_{21} + 66h_{22} \\
   & Z_2 = 118 \\
   & Z_3 = 53 \\
   & h_{11} = \frac{56h_{12} + 66h_{22}}{161.83 + 66.105} = 0.67 \\
   & Z_1 = 105h_{11} + 105.067 = 70.5 \\
\end{align*}$$

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 $h_{ik}$ by 118 (days) and thus obtain:

$$\begin{align*}
   & h_{A1} = 118 \times 67 = 113 \\
   & h_{A2} = 118 \times 67 = 113 \\
   & h_{A3} = 118 \times 67 = 113 \\
   & h_{B1} = 118 \times 67 = 113 \\
   & h_{B2} = 118 \times 67 = 113 \\
   & h_{B3} = 118 \times 67 = 113 \\
   & h_{C1} = 118 \times 67 = 113 \\
   & h_{C2} = 118 \times 67 = 113 \\
   & h_{C3} = 118 \times 67 = 113 \\
\end{align*}$$

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

### Table 9: Optimum Duration of Excavators Work in Each Section, Days and Hours

<table>
<thead>
<tr>
<th>Section</th>
<th>Days</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>B</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>C</td>
<td>113</td>
<td>113</td>
</tr>
</tbody>
</table>

1. The foundations of this method were formulated by J.J. Dantzig in 1949 and published in 1955.

2. "a," should be read "one, one," not as 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:

\[
\begin{align*}
2t_1 + 2t_2 &= 2 \\
2t_3 + 2t_4 &= 2 \\
t_1 + t_2 + t_3 &= 5
\end{align*}
\] (1)

and \(t_1, t_2, t_3\) (all magnitudes of \(x\) are positive); and it is necessary to determine magnitude \(x_0\) for which magnitude \(Z = x_2 - x_1\) is minimum.

In the given case, the variables \(x_0, x_1, x_2, x_3\) 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 \(x_0, x_4, x_5\).

We then obtain:

\[
\begin{align*}
t_1 &= 0; \\
t_2 &= 0; \\
t_3 &= 2; \\
t_4 &= 2; \\
t_5 &= 5.
\end{align*}
\]

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

\[
\begin{align*}
t_1 &= 2t_4 - t_2 \\
t_2 &= 2t_3 - t_1 \\
t_3 &= 3t_2 + t_4 \\
t_4 &= 2 - t_2 + t_1 \\
Z &= 2t_2 + t_1
\end{align*}
\] (2)

Let us find out whether the minimum of \(Z\) is reached at these values of \(t_1\). Evidently, it is not the case, as \(Z\) can be reduced by increasing \(t_1\). However, the increase of \(t_1\) is limited by the condition \(t_1 \geq 0\).

Thus the first of the equations (2) does not impose any restrictions on \(t_1\). As coefficient in \(t_1\) is positive, the equation for \(t_1\) makes it possible to increase \(t_1\) up to 5, and the equation for \(t_2\) to magnitude \(t_1 = 2\) only.

Taking \(t_1 = 2\) and for \(t_2 = 0\), we obtain:

\[
\begin{align*}
t_1 &= 2; \\
t_2 &= 0; \\
t_3 &= 3.
\end{align*}
\]

Thus the new basis from variables which are not equal to zero consists of \(t_1, t_3\) and \(t_5\).

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

\[
\begin{align*}
t_1 &= 2t_3 - t_2 \\
t_2 &= 3t_2 - t_1 \\
t_3 &= 2t_2 + t_4 \\
t_4 &= 2 - t_2 + t_1 \\
Z &= 2t_2 + t_1
\end{align*}
\] (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 \(t_2\).

And as it follows from the system of equations (3), limiting the increase for \(x_2\) is the equation for \(t_2\) only, making it possible to increase \(x_2\) up to 1 only (\(x_4 = 0\), for \(x_2 = 1\) we have \(x_3 = 0\)).

Thus we obtain

\[
\begin{align*}
x_0 &= 0; \\
x_1 &= 1; \\
x_2 &= 4; \\
x_3 &= 9; \\
x_5 &= 0.
\end{align*}
\]

We obtain a new system of equations, repeating again the procedure of replacing main variables (now \(t_1, t_2\) and \(t_3\)) and the value \(Z\) by non-main variables:

\[
\begin{align*}
t_1 &= 4 - 2x_4 - 2x_6 \\
t_2 &= 1 + 3x_5 - 2x_6 \\
t_3 &= 9 - x_4 - x_5 \\
Z &= -3 + 2x_4 + 3x_5
\end{align*}
\] (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.\(^4\)

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.

\[\text{F. Graphical method}\]

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 nature of interchange 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.

\[\text{F. Transport method (distributive)}\]

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.


\(^7\) See, for example, the above-mentioned handbook by M. I. Romanik, "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.

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:

<table>
<thead>
<tr>
<th>X</th>
<th>12</th>
<th>13</th>
<th>15</th>
<th>19</th>
<th>22</th>
<th>27</th>
<th>33</th>
<th>42</th>
<th>46</th>
<th>54</th>
<th>58</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>65</td>
<td>75</td>
<td>85</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Let us group these data as in table 10:

<table>
<thead>
<tr>
<th>X</th>
<th>10-20</th>
<th>(15)</th>
<th>20-30</th>
<th>(25)</th>
<th>30-40</th>
<th>(35)</th>
<th>40-50</th>
<th>(45)</th>
<th>50-60</th>
<th>(55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<tr>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Y</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

The values of \( x_i \), 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 \( \sum m_x = \sum m_y = n = 11 \). 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 inverse.

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, define average values of \( y \), which we shall denote as \( \bar{y_i} \), correspond to different values of \( x \), or average values of \( y \) corresponding to the given values of \( x \). Let us calculate these conditional ( particular) average values of \( y \) and the example given in table 10.

\[
\begin{array}{c|c|c|c|c|c|c}
 X & 15 & 25 & 35 & 45 & 55 & 65 \\
 Y & 75 & 85 & 95 & 100 & 100 & 110 \\
\end{array}
\]

Likewise we find:

\[
\begin{array}{c|c|c|c|c|c|c}
 X & 15 & 25 & 35 & 45 & 55 & 65 \\
 Y & 75 & 85 & 95 & 100 & 100 & 110 \\
\end{array}
\]

We can represent the results obtained in the following form:

<table>
<thead>
<tr>
<th>X</th>
<th>15</th>
<th>25</th>
<th>35</th>
<th>45</th>
<th>55</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>75</td>
<td>85</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>110</td>
</tr>
</tbody>
</table>
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 equation correlation of the following kind is of great importance:

\[ y = ax + b + e \]

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

- **Magnitude of \( r \)** is called co-variation of \( x \) and \( y \) of:

\[ r = \frac{\Sigma xy - \frac{1}{n} \Sigma x \Sigma y}{\sqrt{\left(\Sigma x^2 - \frac{1}{n} (\Sigma x)^2\right) \left(\Sigma y^2 - \frac{1}{n} (\Sigma y)^2\right)}} \]

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

- **Magnitude**

\[ \Sigma x = \frac{1}{n} \Sigma x \]

\[ \Sigma y = \frac{1}{n} \Sigma y \]

\[ \Sigma x^2 = \frac{1}{n} \Sigma x^2 \]

\[ \Sigma y^2 = \frac{1}{n} \Sigma y^2 \]

\[ \Sigma xy = \frac{1}{n} \Sigma xy \]

is the quadratic mean deviation of variable \( x \) is called the co-efficient of the correlation of \( x \) and \( y \) and characterizes the degree of relation between these variables.

This coefficient has the following main properties:

1. Coefficient of correlation \( r \) is always in the interval \(-1 < r < 1\).
2. For \( r = 1 \) or \( r = -1 \) \( x \) and \( y \) are connected by the following direct functional relation \( y = a + b \cdot x \); 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 linear relation.
3. For \( r = 0 \) the straight line relation does not exist, but the curvilinear correlation can exist (for example, the following relation \( y = a + bx + bx^2 \)

For the linear relation in an equation of regression:

\[ y = a + bx \]

The co-efficient of regression \( b \) - angular co-efficient of a straight line - means the increase of magnitude 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.

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 \( x, y \) and \( Z \). The linear correlation between the three variables will be the following:

\[ Z = Z_0 + A(x - x_0) + B(y - y_0) + C \]

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 \( x, y, z \) and \( x, y, z \).

Measurement of the degree (strength) of the linear correlation between two 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 \( X \) and magnitudes of \( Y \) (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 co-efficient of the correlation. The special co-efficient of the correlation between \( X \) and \( Z \) is denoted by \( R_{xz} \), which signifies a measure of the linear relation between \( X \) and \( Z \). 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 co-efficients of the first (second, third etc.) order.

The properties of the special co-efficient of correlation are similar to the properties of an ordinary co-efficient 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 13 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 of coke costs 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 1,130 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. Emeliansenko and N. V. Panamaikina 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 0.00009.

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 Lubian Borma

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 human capital. 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 are needed. In other periods of development, the training of scientific personnel, for example, is needed.

Capital investments in fixed assets may be classified roughly in three groups: investments aimed at replacement of substandard in order to reduce costs and increase productivity and competitiveness and at the establishment of new capacities. In most cases these groups cannot be distinguished precisely, because it usually brings modernization and often widening of capacities and establishment of new capacities (or replacement of old assets) in a general train of resources in the economy. As a rule, the solution to these problems may be considered the question of economic efficiency and the expansion of the output. That follows, this study will focus on investment projects and relate them to the establishment of new capacities. The development of economic relationships involves the establishment of capital goods, which can be divided into three general groups: the establishment of new capacities in the establishment of new capacities, the establishment of new capacities and the establishment of new capacities and the establishment of new capacities. In the present study, the term productive investments will be used to define the main part of the process.

By interindustrial aspects of investment activity is mean the analysis and consideration of interindustrial relationships influencing the balance and efficiency of investments and of the economy, as well as of the problems of distribution of investments by sectors or branches of the economy. Although interindustrial relations in developed economies are much more numerous and complex than in developing countries, the analysis of such relations in developing countries is more important owing to the special sensitivity of these economies to structural changes and imbalance in development.

The investment process includes various activities. It starts with a preliminary design of development serving as a general framework of resource allocation. It includes preselection 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 these countries, such mechanism is not only to an equilibrium but also to ensure efficient allocation of resources and a sustainable path of growth. The means means that individual efforts are concentrated in the first place on measures and on other information are generally made concerning both current production and investment activity. We may add however, that the price mechanism cannot fully its function of optimization only in case of perfect competition. A condition generally 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
production and—perhaps even on a larger scale—in 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, usually used 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 anticipation), 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 its quality 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 for the full life of the projects. Present and future values made equivalent by discounting methods (present worth or annuity) are recommended in both cases and is in fact widely practiced.

Recent research has also investigated the actual motives of investment decisions of private entrepreneurs and the calculations and evaluations actually performed. 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 both directly 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) rates of time-series demand and supply curves and conditions investment 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 for such steps may reduce the risks and imbalances of growth. Price serves as a criterion 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: '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 more rational and informed base of making investment decisions.'

C. PROJECT EVALUATION IN CENTRALLY PLANNED ECONOMIES

Within the group of countries known as United Nations industrialized countries, with centrally planned economies and among themselves, 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, the 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 the countries and in some of their significant changes and improvements are going to take place in the context of central planning and administration of the economy.

From the point of view of investment issues and project evaluation problems, centrally planned economies are perhaps best described either as a market economy which is accorded the privilege of central planning but according to a size of country and share in foreign trade. Their economic development is related to a large or medium scale of state expectations and to more experimental investment and the distinction between developed and developing economies. As for size of country and share in foreign trade there is no one good and general criterion. The smaller, relatively self-sufficient countries with a population of over 20 million and on the other hand, medium sized countries of central Europe among them, Hungary is a high share of investment in its foreign trade.

To begin with the common feature in centrally planned economies is the overwhelming proportion of investments (and the new capital stock) which are financed by central state funds. In the framework of a fairly detailed statewide planning, the central institutions determine the total investment expenditure of the country and its development, the distribution between heavy, heavy industry, and small and medium industries. The final analysis by productive investments are distributed among various industrial branches of the economy, but in intersectoral (i.e. interbranch) and the selection will appear in the form of projects centrally planned and not in projects on initiative of lower authorities.
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, substantive 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 equalize time differences in the implementation of projects, discounting methods are also applied. The relationship 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. 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 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. Problems about the adequacy of actual prices has led to experimental uses of accounting prices to measure domestic in-puts (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. Intermunicipal 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.

1) 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 economics essentially by the same criteria 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 "underdeveloped" areas were raised in the literature on the subject some twenty years ago, and many criteria of project evaluation, theoretical considerations...
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—"source 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, as the first with labour. The more comprehensive criterion of "social marginal productivity" was suggested by A F 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 quantification of this SMP criterion, however, raises serious problems and it may be and has in fact been criticized for neglecting time aspects of efficiency. The "marginal per capita revenue quotient" theory put forward by Galenson and Liebenstein 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, 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 results according to single criteria. A survey of the practice of six developing countries prepared by the United Nations Division of Industrial Development 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, 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 overall 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 overall and sectoral programming.

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. We have not surveyed the specific motives of investment decisions in those countries, but it is often pointed out by experts with practical
experience that simple rule-of-thumb, scarce-factor
approaches or selection of "key sectors" predomi-
nate. 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 pro-
cedures. It further underlines the importance of
adopting project evaluation methods to real decision
processes and to the various stages and motives in
these 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 in-
vestment activity and that the required investment
in the backward or forward linked industries may
not take place if it is solely dependent on the entre-
preneurial 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 estab-
lishments contribute to the balanced growth of 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 capaci-
ties manufacturing domestic intermediate prod-
ucts for other intermediate 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 dis-
counting methods). For the total set of projects,
and for the economy as a whole, it presents serious
difficulties. Usually one typical or certain selected
cases are analysed in this connection.

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 ma-
terials 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 (mar-
ket) 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—con-
sumption, gross investment and export. Strictly
speaking, capital and imports, if not received as for-

tign 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 produc-
tion requires time, and they serve production for
more than one consecutive cycle. Imports are limi-
ted too, since as a rule they must be paid for by

equivalent export goods (excluding the case of
for
tign 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 in-
puts, 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 pro-
duction 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 simulta-
neously. Therefore consistency must be analysed
and satisfied not only by final goods and primary
inputs but also by intermediary stages of produc-
tion, that is, by sectors and branches of the econ-
omy. The construction of new establishments adds
new capacities, new production units to a given
sector or branch, but at the same time may require
additional 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 (un
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 (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 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 programming, further data are required, too, but this selection of the best combination of feasible projects takes into account theoretically all the interindustry 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 interindustry 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 not only materials but also important intermediary and final goods, mostly in physical units. The supply side of these balances comprises 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 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 breakdown. 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, by 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 table available as 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 macroeconomical (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. 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 c. 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. 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-output 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. 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.

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, Sales No.: 58 I l G 3), 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 labor inputs. Accounting prices must be determined for capital in each case, and preferably for categories of skilled and unskilled labor 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 rate may be recommended too.

Fourthly, actual (market) prices do not deviate from social values on a large scale at a given point in time, only modifications resulting from change 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 approximate 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.

Fifth, where an input-output table is sufficiently detailed, the attempt may be made to design a total system of accounting prices reflecting actual macroeconomic costs with complete redistribution of taxes, subsidies and profits, by means of a macroeconomic 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 overall 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. 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. Furthermore, with a mixed use of actual (market) and accounting prices, renounces the consistency of the valuation. As a rule, primary inputs such as capital, labor 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 basis 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 preliminary.

The programming approach seems to be superior if it requires much more basic data. In case of a limited number of feasible projects, all these alter...
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 programming. 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 (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 as for 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 allow making 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 defined at all, 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.

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 INDUSTRY EFFICIENCY EFFECTS ON PROJECTS

Theoretically, programming methods may yield the best project evaluation but in 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 programming in process analysis for sectors of the economy, for project evaluation within sectors. Thus, for instance, in Hungary, both programming methods have been applied for development planning of the cotton weaving industry, paper industry, aluminium industry and many other. In the industry there concave programming has been applied to. We are interested here, however, in the interindustrial aspects of project evaluation which are taken into account in sectoral programming mostly in a very limited way.

Some experiments on intersectoral, i.e. econ- omy-wide, programmatic methods are known too, but they do not seem to give direct project evaluation and selection. The experience now gaining in the Hungarian Planning Office known to the local planning, is an iterative calculation of economic sectoral programmatic methods. A typical question is: "It seems that project planning has been done up to the sectoral level but what work and indication has been done up to the divisional level?"

III. THE RESULTS OF THE SECTORAL PROGRAMMATIC METHODS CAN ALSO BE USED TO ACCURATELY OBTAIN THE ACCOUNTING PRICES.
of programming can lie 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. The methods suggested along the same lines in the Soviet Union, in the first place by L. V. Kantorovich and V. V. Nasonov, are intended to achieve approximate 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 overall programming of the economy may be a preliminary allocation (distribution) of investments among sectors. Sectoral programming and single-project evaluations may correct this distribution. Nevertheless, this distribution provides an important starting point for further analysis. The investment-computational machinery 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, they 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 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. The latter indicators may be called total macroeconomic labour input coefficients. Furthermore, the usual total capital input 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 scarce 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 violating 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.
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 as well. Method (e.4), always, and method (e.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 programming.) That is one of the reasons why sectoral evaluation, or preselection or predetermination 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. Second, the constraints of the aggregated sectoral 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 rated less efficient from a macroeconomic point of view than some "wrong" projects of another sector which have been eliminated. Owing to the excessively 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 prediction 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, 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.

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, economic wide mathematical programmes 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 overall 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.1.12) with care at the project selection method and the total primary input approach (e.3-4), with some difficulty and at programmes (e.3-5) 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 calculations may be recommended for sectoral evaluations, without discounting procedures.

For project evaluation, partial criteria, their combination with or without weighting, or one not 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 evaluations, 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, e.g., skilled and unskilled labour, foreign currencies, etc. From a macroeconomic point of view, the primary input requirements are to be analyzed 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:

Domestic value added at accounting prices

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. Timmergen 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)." 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.

1. 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, imports, price relations, infrastructure. In spite of these factors, some empirical investigations (by W. Leontief, H. B. Chenery, T. Watanabe and others)
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 1989, for instance, of the possible 91,800 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 represent 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. In terms 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 on 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 technologies. 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 may be possible also some further monetary adaptations. For these calculations, however, first a model conversion of the base national data of the main projects in the common currency. By this way the direct analysis of the consistency effect of the projects (or its) may be supplemented by an input-output evaluation of the consistency impact. If the analysis of the impacts on primary input requirements, the calculation of the row vector 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 analysis are described elsewhere (4) may be used too. For further analysis 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 furnishing production

<table>
<thead>
<tr>
<th>Supplier sectors</th>
<th>Projected demand</th>
<th>Calculated* total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Requirements in million national currency units</td>
<td>(in percentage)</td>
</tr>
<tr>
<td>Mining</td>
<td>0.5</td>
<td>5.2</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>1.5</td>
<td>6.9</td>
</tr>
<tr>
<td>Machinery and instruments</td>
<td>0.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Other metal products</td>
<td>4.1</td>
<td>5.5</td>
</tr>
<tr>
<td>Electric power</td>
<td>3.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Building materials</td>
<td>2.0</td>
<td>4.2</td>
</tr>
<tr>
<td>Chemicals, rubber and plastic products</td>
<td>5.0</td>
<td>10.7</td>
</tr>
<tr>
<td>Wood</td>
<td>30.7</td>
<td>40.9</td>
</tr>
<tr>
<td>Paper and printing</td>
<td>0.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Textile</td>
<td>17.2</td>
<td>21.3</td>
</tr>
<tr>
<td>Leather, apparel</td>
<td>0.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Food</td>
<td>1.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Domestic intermediary goods</td>
<td>73.7</td>
<td>100.4</td>
</tr>
<tr>
<td>Imported goods</td>
<td>29.0</td>
<td>43.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>102.7</strong></td>
<td><strong>153.6</strong></td>
</tr>
</tbody>
</table>

*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*

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Taxes and subsidies</th>
<th>Returns to capital/profits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Total</td>
</tr>
<tr>
<td>201 Field crops</td>
<td>-3.9</td>
<td>-1.5</td>
</tr>
<tr>
<td>202 Livestock</td>
<td>4.4</td>
<td>5.3</td>
</tr>
<tr>
<td>203 Citrus</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>204 Other agriculture</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>205 Mining</td>
<td>1.0</td>
<td>3.8</td>
</tr>
<tr>
<td>206 Fossil</td>
<td>0.9</td>
<td>4.0</td>
</tr>
<tr>
<td>207 Textiles and apparel</td>
<td>5.2</td>
<td>6.3</td>
</tr>
<tr>
<td>208 Wood and carpentry</td>
<td>12.4</td>
<td>14.8</td>
</tr>
<tr>
<td>209 Paper, printing and publishing</td>
<td>3.7</td>
<td>7.3</td>
</tr>
<tr>
<td>210 Leather and leather products</td>
<td>1.4</td>
<td>3.3</td>
</tr>
<tr>
<td>211 Rubber and plastic products</td>
<td>6.3</td>
<td>8.4</td>
</tr>
<tr>
<td>212 Chemicals, coal and soap</td>
<td>6.0</td>
<td>8.4</td>
</tr>
<tr>
<td>213 Oil refineries</td>
<td>0.1</td>
<td>1.1</td>
</tr>
<tr>
<td>214 Glass, ceramics and cement</td>
<td>8.9</td>
<td>12.6</td>
</tr>
<tr>
<td>215 Diamond polishing</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>216 Basic metals</td>
<td>1.0</td>
<td>3.6</td>
</tr>
<tr>
<td>217 Metal products</td>
<td>4.9</td>
<td>7.3</td>
</tr>
<tr>
<td>218 Machinery and vehicles</td>
<td>6.9</td>
<td>9.9</td>
</tr>
<tr>
<td>219 Construction and housing</td>
<td>6.6</td>
<td>11.5</td>
</tr>
<tr>
<td>220 Electric power</td>
<td>3.1</td>
<td>5.0</td>
</tr>
<tr>
<td>221 Water</td>
<td>-13.2</td>
<td>-9.4</td>
</tr>
<tr>
<td>222 Inland transportation</td>
<td>0.2</td>
<td>10.4</td>
</tr>
<tr>
<td>223 Shipping and aviation</td>
<td>1.1</td>
<td>2.4</td>
</tr>
<tr>
<td>224 Other communications</td>
<td>4.0</td>
<td>6.7</td>
</tr>
<tr>
<td>225 Services and trade</td>
<td>5.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*In percentage of the value of output. Taxing coefficients calculated from input-output table. Sources: H. Bruen, Interdependence, Resources Use and Structural Changes in Israel, Jerusalem, 1968, pp 50-60.*
### ANNEX III

**SHARE OF DIRECT AND TOTAL SALES TAXES AND SUBSIDIES IN THE HUNGARIAN ECONOMY IN THE YEAR 1959**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Sales taxes and subsidies</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Total</td>
<td>Direct</td>
<td>Total</td>
</tr>
<tr>
<td>Mining</td>
<td>0.3</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallurgy</td>
<td>0.4</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>0.1</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>-0.3</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruments</td>
<td>5.4</td>
<td>7.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other metal products</td>
<td>5.0</td>
<td>7.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric power</td>
<td>0.0</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building materials</td>
<td>0.3</td>
<td>8.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemicals</td>
<td>15.4</td>
<td>23.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber and plastic products</td>
<td>37.0</td>
<td>43.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>9.8</td>
<td>13.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>13.1</td>
<td>15.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printing</td>
<td>7.2</td>
<td>14.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textile</td>
<td>30.7</td>
<td>38.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leather</td>
<td>13.2</td>
<td>18.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparel</td>
<td>20.3</td>
<td>41.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>10.6</td>
<td>14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>0.3</td>
<td>1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.0</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport and communication</td>
<td>16.8</td>
<td>13.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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-output table for the year 1961.

#### A. Basic data

<table>
<thead>
<tr>
<th></th>
<th>Brick and tile products</th>
<th>Cement and concrete products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage share of value of output</strong></td>
<td>Direct input</td>
<td>Total input</td>
</tr>
<tr>
<td>(i) Domestic intermediate goods</td>
<td>33.0</td>
<td>49.3</td>
</tr>
<tr>
<td>(ii) Imported goods</td>
<td>8.1</td>
<td>12.7</td>
</tr>
<tr>
<td>(iii) Depreciation</td>
<td>10.9</td>
<td>16.5</td>
</tr>
<tr>
<td>(iv) Wages and salaries</td>
<td>27.7</td>
<td>39.7</td>
</tr>
<tr>
<td>(v) Profits</td>
<td>15.7</td>
<td>21.0</td>
</tr>
<tr>
<td>(vi) Taxes and subsidies</td>
<td>4.6</td>
<td>8.1</td>
</tr>
<tr>
<td>(vii) Total value of output</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>(viii) Capital requirements</td>
<td>148.4</td>
<td>204.1</td>
</tr>
</tbody>
</table>

#### B. Variants of accounting prices (per 100 units of value of output at actual prices)

<table>
<thead>
<tr>
<th></th>
<th>Brick and tile products</th>
<th>Cement and concrete products</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) By eliminating taxes and subsidies paid at the given stage of the production process</td>
<td>95.4</td>
<td>86.2</td>
</tr>
<tr>
<td>(ii) By eliminating total tax on output</td>
<td>91.9</td>
<td>82.6</td>
</tr>
<tr>
<td>(iii) By eliminating total profits, taxes and subsidies</td>
<td>78.9</td>
<td>58.2</td>
</tr>
<tr>
<td>(iv) Based on total macroeconomic labour input in wages terms</td>
<td>56.0</td>
<td>43.7</td>
</tr>
<tr>
<td>(v) Based on total macroeconomic labour input + charge on wages 25 per cent</td>
<td>90.0</td>
<td>75.5</td>
</tr>
<tr>
<td>(vi) Based on total macroeconomic labour input + charge on wages 15 per cent + charge on capital 10 per cent</td>
<td>107.0</td>
<td>90.2</td>
</tr>
<tr>
<td>(vii) Based on total macroeconomic labour input + charge on wages 25 per cent + charge on capital 10 per cent</td>
<td>104.5</td>
<td>89.8</td>
</tr>
</tbody>
</table>
ANNEX IV (continued)

C. Methods of calculation, illustrated by the example of the brick and tile products

\[(i) = (g) - (f_1) = 100 - 4.6\]
\[(ii) = (g) - (f_2) = 100 - 8.1\]
\[(iii) = (g) - (f_2) - (e_2) = 100 - 8.1 - 23.0\]
\[(iv) = \text{total labour} + \text{total import converted in labour (based on average cost of foreign currency earned by exports + total depreciation converted in labour (based on average costs of the replacement of the fixed assets)} = 39.7 - 7.6 + 8.7\]
\[(v) = (iv) \times 1.75 = 56.0 \times 1.75\]
\[(vi) = (iv) + C_{im} \times 0.15 = 56.0 + 345 \times 0.15\]

where \(C_{im}\) = total macro-economic capital requirement including requirements of imports (via exports) and depreciation (via replacement).

\[(vii) = (iv) \times 1.25 + C_{im} \times 0.10 = 56.0 \times 1.25 + 345 \times 0.10\]

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.

<table>
<thead>
<tr>
<th>A. Basic data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data per 100 units of value of output at actual prices</strong></td>
</tr>
<tr>
<td><strong>Sector A</strong></td>
</tr>
<tr>
<td>Accounting prices for output at foreign currency equivalents (FCE)</td>
</tr>
<tr>
<td>Imported goods used at FCE</td>
</tr>
<tr>
<td>Direct</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Labour input (in 10^4 man years)</td>
</tr>
<tr>
<td>Direct</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Capital requirement</td>
</tr>
<tr>
<td>Direct</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Total macro-economic labour</td>
</tr>
<tr>
<td>Labour (in 10^4 man years)</td>
</tr>
<tr>
<td>Import at FCE</td>
</tr>
<tr>
<td>Capital requirement</td>
</tr>
</tbody>
</table>

ANNEX V (continued)

B. Sectoral characteristics

<table>
<thead>
<tr>
<th>Per 100 units of output at FCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sector A</strong></td>
</tr>
<tr>
<td>Total labour (10^4)</td>
</tr>
<tr>
<td>Total macro-economic labour (10^4)</td>
</tr>
<tr>
<td>Total capital requirement</td>
</tr>
<tr>
<td>Total macro-economic capital requirement</td>
</tr>
<tr>
<td>Total import at FCE</td>
</tr>
<tr>
<td>Total macro-economic import at FCE</td>
</tr>
<tr>
<td>Total capital requirement per total labour (10^4)</td>
</tr>
<tr>
<td>Total import at FCE per total labour (10^4)</td>
</tr>
</tbody>
</table>

C. A synthetic formula of efficiency calculation

<table>
<thead>
<tr>
<th>Domestic value added per 100 units of output at actual prices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sector A</strong></td>
</tr>
<tr>
<td>Domestic costs of accounting prices per 100 unit of output at actual prices</td>
</tr>
<tr>
<td>Variant (vi)</td>
</tr>
<tr>
<td>Variant (vim)</td>
</tr>
<tr>
<td>Variant (vim)</td>
</tr>
<tr>
<td>Domestic value added per domestic costs</td>
</tr>
<tr>
<td>Variant (vi)</td>
</tr>
<tr>
<td>Variant (vim)</td>
</tr>
</tbody>
</table>

*Total macro-economic labour input includes total import and total depreciation converted in labour (see annex IV (C)). Total macro-economic import indicates import needed to depreciation for replacement of fixed assets. Total macro-economic capital requirement includes capital needed by import for equivalent export production.
XI. CRITERIA FOR THE EVALUATION OF INDUSTRIAL PROJECTS IN AN OPEN ECONOMY

by L. Cseppe and M. Mandl*

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 33.7 per cent of the national income and agriculture contributed 36.5 per cent, in 1961, 20.3 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, 40.1 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 38 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 1949. Before the war some 15 to 20 per cent of total investments were spent on industry annually (while between 1950 and 1962, with the exception of two years, the share of industry in total investment methods 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 lesson 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 fulfill them on "economic stations 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. Thus, 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 use of the means is calculated at these 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-
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 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 growth 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. The 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 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, 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:

<table>
<thead>
<tr>
<th>Sector's Total Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>(1) Main products</td>
</tr>
</tbody>
</table>
| 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 not exported but could be exported |
|                      |
| (2) Secondary products|
| A smaller part of output |
| Products not characteristic of the sector's profile but of the sector's having little weight profile |
|                      |

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 method, 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 identifi-
cation" 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 ex-
change 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 vari-
ous sectors have changed between 1951 and 1961.
Let us suppose further that sector A had:

<table>
<thead>
<tr>
<th>Year</th>
<th>Output</th>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance of foreign exchange</td>
<td>$200 million</td>
<td>$140 million</td>
</tr>
</tbody>
</table>

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 | New index | Balance of foreign exchange | Change in balance of foreign exchange vs.
<table>
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<tr>
<td>1961</td>
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</tbody>
</table>

Total $125

Taking into account production increases only and
extrapolating changes of foreign exchange yields
during eleven years, foreign exchange earnings origi-
nating from sector A are $125 million total (dis-
count 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 ex-
change values of invested capital by sectors. Applying
the method described above, we expect to get the
following results:

1. When the "world price model" is completed,
all basic data we need to calculate net foreign earn-
ings of a project, sector, or the national economy
as a whole are given;

2. We will have a sound basis (difference among
sectors in net foreign exchange earnings) for sec-
torial allocation of investment funds based on the
principle of maximization of net foreign exchange
earnings (as the most important indicator of effi-
ciency in an open economy);

3. With the help of a dynamized "world price
model" we expect to have a good method for elabo-
ration long-term investment programmes.

4. 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 to practice our principle that, in an
open economy, the most important criterion of pro-
ject evaluation is the net foreign exchange earn-
ings 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
different sectors on the one hand and the world price
trends calculated or post which might be used as a
starting point for estimations of world market price
trends or ante on the other hand. There are some
other aspects of project evaluation in an open eco-

omy which have to be considered in the consideration
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 the more
cases we have to deal with fifteen to twenty-five
years, the higher the number of uncertainty factors.
In connection 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 invest-
mment funds in those branches where expected for-

These 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 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 discussion 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 motto 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 disturbing 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 B12 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 B12 vitamin 1959-1964 (in $US gramme)**

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<tbody>
<tr>
<td>100</td>
<td>85</td>
<td>42</td>
<td>16.5</td>
<td>9.5</td>
<td>8</td>
<td>6.6</td>
</tr>
</tbody>
</table>

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 1973 for some artificial fibres and fer 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 assumed 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 curve clearly indicated world price movements or post. These export analyses have been used as starting points towards an 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 benso, fenol, toulon and paraxked, the so-called aromatic compounds. Since these products are produced from the same base material (coal bitumen or by petrochemistry), 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 basis; 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 correction for 1965. After ex post analyses had been considered, the 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 bases 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.

**Expected costs of 1 $US of aluminium on Hungarian market in 1973 (in $US)**

<table>
<thead>
<tr>
<th>Material</th>
<th>$US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric energy</td>
<td>4.90</td>
</tr>
<tr>
<td>Aluminium scrap</td>
<td>10.00</td>
</tr>
<tr>
<td>Knapsack and ammunition</td>
<td>8.00</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>4.00</td>
</tr>
<tr>
<td>Labour costs</td>
<td>10.00</td>
</tr>
<tr>
<td>Estimated</td>
<td>20.00</td>
</tr>
</tbody>
</table>
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.

### Alumínium Prices

<table>
<thead>
<tr>
<th>Year</th>
<th>Canada ($/ton)</th>
<th>Norway ($/ton)</th>
<th>Hungary ($/ton)</th>
<th>USA ($/ton)</th>
<th>UK ($/ton)</th>
<th>France ($/ton)</th>
<th>Italy ($/ton)</th>
<th>W. Germany ($/ton)</th>
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<tr>
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</tbody>
</table>

Changes in the above prices deflated by wholesale price index and transported to Hungarian exported prices in 1960 (to western markets)

<table>
<thead>
<tr>
<th>Year</th>
<th>Canada ($/ton)</th>
<th>Norway ($/ton)</th>
<th>Hungary ($/ton)</th>
<th>USA ($/ton)</th>
<th>UK ($/ton)</th>
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A number of conclusions may be drawn from these figures:

1. We cannot formulate a regression function because there are three different periods.
5. 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).
6. Capacities have increased and are rising slightly, while a decreasing rate of use of aluminium products is highly probable.
7. Presumably the price level will oscillate around production costs.
8. The minimum expected cost level is $430 per ton. If the expected cost is equal to $430, the American producers cannot hold this level, since American labour costs are higher than $2 per hour. Therefore the difference between United States domestic and international price levels will increase.
9. 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 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 connections 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, 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 \( \max \rightarrow \to \infty \). 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 investment funds 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 coordination is mechanized, since every important plan target is included 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, allowed capital, rate of interest \( (r) \) for investment, wage taxes, rent, mine rent, rates of exchange difficulties, export-import duties, taxation. 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 plan-balancing methods.

It is obvious from the requirements of model building and programme determination 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 terms of criteria for project evaluation by programming some other aspects in addition to the stability and 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 capacity, 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-harvesters, 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 natural qualities of the product. In the case of homogeneous products (artificial fibres, products 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 (mV)

(ii) Linearity measured by %

(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 m²

(b) Comparison of parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>German TV set</th>
<th>Hungarian TV set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selectivity</td>
<td>100 mV</td>
<td>45 mV</td>
</tr>
<tr>
<td>Linearity</td>
<td>max 3 %</td>
<td>2 %</td>
</tr>
<tr>
<td>Tube size</td>
<td>53 cm</td>
<td>40 cm</td>
</tr>
<tr>
<td>Line frequency</td>
<td>600 lines</td>
<td>500 lines</td>
</tr>
<tr>
<td>Channels</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Automatic function</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Adaptability</td>
<td>100 W</td>
<td>100 W</td>
</tr>
<tr>
<td>Weight</td>
<td>6 kg</td>
<td>10 kg</td>
</tr>
<tr>
<td>Size</td>
<td>0.122 m²</td>
<td>0.11 m²</td>
</tr>
</tbody>
</table>

The parameters of the better product are taken as a limit and the parameters of the other product are related to the norm 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-based these technical parameters have been computed 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 even cases the same in one and worse in one case.

7. Some Technical Observations

In the present stage all available technology of man must be collected and considered. At this stage we do not have to choose and evaluate them. The opportunity is to investigate all the existing models of course will have the number of possible technological variants the number of variants will be limited by computer capacity and time but we have to go through all the possible variants before we start model building. In case we come to the conclusion that the technology is not available at all we should have to analyse the possibility of developing a new and more suitable technology or of supporting 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 investment, capacity, and other factors of the new project. In connection with technical fibre programming for example planners considered nineteen technological variants. In our recent practice technological variants have been built 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 efficient computations).

8. Machinery demands or standardisation

Machinery requirements should be determined in the basis of analysis of possible technological variants. By comparison with planned machinery the following aspects should be taken into account:

Purchasing possibilities of new machinery and appliances. (The present catalogue is important)
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 infrastructure 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 (local or 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:
- Methods based on the evaluation of labour costs;
- 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 Novozhilov and Kintuoros 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 endowments 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 the conditions formulated by the target function of the economy. According to the opinions 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 price 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 scarcer 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 connection 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? 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 basis for evaluation. It is an accepted principle today to use official or an even 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: long output technique is quite developed in our country and foreign trade plays a decisive role, while computer capacities are 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 in hand and experiment with others in the meantime.

C 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 on production (or project) is deemed efficient which ensures the planned rate of growth of national income. The balance method therefore essentially 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 the resources for the national economy as a whole. In consequence of this system of direction and planning, investment 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 realisation) 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 equilibration) 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 to choose 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 a long period of time before 1947 efficiency calculations for investment planning were not elaborated at all.

We have tried to use efficiency calculations for each project since 1947; 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 revision in the present system of directions and planning which are at present under discussion and a return 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 short-margins

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 project 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 realization:
  - 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 connection 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 connection with project evaluation. We shall therefore try to analyze 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 analyze 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 equal 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 amounts of each of the trades are not given within these narrow limits. Therefore central direction usually allows inventors to prepare additional documents reflecting trade aspects.

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 inventors, 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 superfluous 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 works 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, price and size, 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:

(a) Labour (skilled, unskilled, white collar technical etc).

(b) Energy consumption (fuel etc), electricity etc by quantities and supply sources (domestic or imported).

(c) Material (domestic, imported, payment value, supply sources etc).

(d) Transportation requirements.

(e) 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 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.

1. Efficiency methods in practice and their criticism

The methodology of present efficiency calculations is based on the following principles:

(e) Annual inputs and costs of annually repeated inputs (d)

Since the dimensions of these two types of costs are different (dimension of \( E \) is forint—domestic currency and dimension of \( o \) is—(forint) a common year 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 methodology as \( \Delta \) (In the literature this coefficient has other names, such as: normative of profitability, interest etc.) The dimension of \( \Delta \) is 1. The reciprocal value of \( \Delta \) is the recovering year of the project expenses expressed in years. The \( \Delta \) makes it possible to aggregate these two types of inputs in two forms:

(i) \( \Delta \cdot \frac{a + B}{\Delta} \)

(ii) \( \Delta \cdot \frac{a}{\Delta} + B \)

Usually the first form is accepted in the practical valuation process. The \( \Delta \) plays a very important role in efficiency computations. The methodology defines the \( \Delta \) 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 \( (b, a) \); this liberated labour unit should be supplied with tools of production, indicated by \( (b, a) \); therefore one unit of value of new production annually requires \( b, a \) investment expenses. The relationship expressed in an algebraic form is:

\[ b \cdot a = b \cdot a \text{ (Ft/year)} \]

In order to reduce the different dimensions, the equation should be divided by \( (b, a) \):

\[ 1 \text{ Ft/year} = \frac{1}{b \cdot a} \text{ (Ft/ year)} \]

Consequently \( \frac{1}{b \cdot a} \) is the annual amount of new value produced by 1 forint of investment expenses.

This \( \frac{1}{b \cdot a} \) value is called efficiency coefficient of \( \Delta \).

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. This new value ensured for year (\( n \)) by the total
amount of invested resources \((B)\) after installment 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
\( \Delta \) = efficiency coefficient
\( q \) = proportion of accumulation in national income

Value of time element \((b_n)\) = \(1 + t_n\)

Computation should be elaborated on national and factory levels. To measure the profitability of the project, methodology contains the following indicators:

1. In case of projects of capacity expanding type
   Indicator of profitability on national level:
   \[ g_n = M + A_n + A_i + L + \Delta / B + F + B_k \]

where: \( g_n \) = profitability on national level
\( T \) = value of production on world market
\( M \) = wages
\( A_n \) = domestic material
\( A_i \) = import material on world market prices
\( L \) = expenditures on circulating capital
\( \Delta \) = efficiency coefficient \((0.20)\)
\( B \) = investment expenses \((\text{fixed capital})\)
\( F \) = 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 forintes and national 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:

<table>
<thead>
<tr>
<th>Installment</th>
<th>Inverted Value</th>
<th>Time Factor</th>
<th>Input corrected</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>100</td>
<td>1.1</td>
<td>110</td>
<td>1.1</td>
</tr>
<tr>
<td>2 years</td>
<td>100</td>
<td>1.1</td>
<td>110</td>
<td>1.1</td>
</tr>
<tr>
<td>3 years</td>
<td>100</td>
<td>1.2</td>
<td>120</td>
<td>1.2</td>
</tr>
<tr>
<td>4 years</td>
<td>100</td>
<td>1.1</td>
<td>110</td>
<td>1.1</td>
</tr>
<tr>
<td>Total invested</td>
<td>400</td>
<td></td>
<td>520</td>
<td></td>
</tr>
</tbody>
</table>

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:

\[ B_k = 2.5 \cdot I_k \]

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 \((\text{material and amortization})\) 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:

\[ g_f = M + A_n + A_i + E + B_k \]

This formula is used for the calculation of profitability only at the last technological stage.

2. Formula of labour-saving projects

On labour-saving projects, results 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 expense increase, the value of total input should be decreased by the amount of related investment expense. The formula is as follows:

\[ B = B - B_k \]

where \( B \) = efficiency of labour saving projects.


d\text{costs before the investment} 
\delta_i = \text{costs after the investment} 
B = \text{costs of the project} 
\Delta_i = \text{related investment expenditures} 
F = \text{circulating capital needs} 

It may be seen from the above formula that this is an indicator of the turnover type. The reciprocal of \((\text{Gii})\) 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 $250 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 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 the 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 (b_k) of 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 rates 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 1958:

\[
\{ \frac{1}{B_n} \cdot B \} = 0.526 \text{or } 100 \cdot 0.526 \text{ units}
\]

If we take the 52.6 units and recapitulate 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:

\[
gf = \frac{T}{M + (A_n + A_k)}
\]

value of production \(T\) should be calculated in world market prices while items calculated in domestic prices \((A_n + A_k + L)\) should be deducted from that value of production calculated in world market prices. As a consequence, the numerator has no real economic meaning. If for example \(T = (A_n + A_k + L)\) the value of the fraction will be (01) or (00). 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, i.e. 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 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 1947 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 economic", 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 nor 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 tough estimates which we criticize so sharply.

a. State 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 level of risk taking below.

t. 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 large integrated corporation may take 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, have been uninterpreted for a long time by many economists who presumed that in a centrally planned socialized 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 connection with mathematical programming on the sectoral level. In sectoral programmes, planners use "zones of data" instead of single fixed data. Zones of data was expressed by many to: It provide an opportunity to indicate the degree of uncertainty on the one hand and to elaborate various variants on the other. Uncertainty is indicated for decision-makers by the space of the zone, the bigger the zone the better the certainty. The space and time factor. 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 unattainable 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:

- $K_{\text{max}}$: maximum costs
- $K_{\text{min}}$: minimum costs
- $K_0$: average costs
- $K_{\text{level}}$: level of certainty value of costs, condition $0.5
- $K_0 = K_{\text{level}} + (K_{\text{max}} - K_{\text{min}}) / 2 = 0.5$
- $K_0 = K_{\text{level}} + (100 - 70^* (0.70 - 0.50) = 85 + 6 = 91$

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 at 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, impedes 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 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...
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 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 connection with cost of efforts. 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 seller's 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.

(c) 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 distributed 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. In stage of decision, or a part of it, comes rather 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 this stage. Approval of construction of single projects under 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 question, 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 two parts, in time and space, is the root of several difficulties and in many cases cannot be avoided. The second-stage influences the first. It may happen that a planned project cannot be realized for various reasons and the original plan targets may be changed, or that because of changes in plans other projects which have already been approved are 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 connection 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. 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 disposability 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. 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. 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 in the unemployed.

1 The following estimates are taken from V R K Tripe, “Unemployment statistics in India,” Economic Weekly, Bombay, 1965, p 27.

<table>
<thead>
<tr>
<th>Year</th>
<th>First plan</th>
<th>Second plan</th>
<th>Third plan</th>
<th>Fourth plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>Not available</td>
<td>1951</td>
<td>1961</td>
<td>1966</td>
</tr>
</tbody>
</table>

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. Such an assumption is implicit in F. Bator's well-known need to assume that the choice of a rate of saving can be made independently of the distribution of income. See F. Lewis, “Economic development with unlimited supplies of labor,” 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.
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 of the employed worker is limited. Joseph Pajeszka
notes that the attempts of the Polish Government to do just that in the decade following the defeat of
the 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 develop-
ment".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 worthwhile exploring its implications for development policy.

A. Technique and Savings 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, x) 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

\[
\text{Min } = \int_{0}^{x} \{B - U(C(t))\} \, dt \tag{1}
\]

Let \( \rho \) stand for the output: capital ratio, \( K \) for capital, \( K^* \) for investment, and \( V \) for income. Then

\[
\frac{V}{\rho K^*} = \frac{C}{\rho K - K^*} \tag{2}
\]

And expression (1) becomes

\[
\text{Min } = \int_{0}^{x} \{B - U(\rho K(t) - K^*)\} \, dt \tag{5}
\]

If we apply the calculus of variations to expression (5), the first order Euler-Lagrange equation becomes

\[
-\frac{\partial U}{\partial V} = \frac{\partial \lambda}{\partial V} \tag{6}
\]

or

\[
-\frac{U}{V} = \frac{\lambda}{U_t} \tag{7}
\]

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 development programme in increasing the volume of savings and employment by taxation or inflation, the more difficult 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 loose from taxation and inflation.


7 We shall assume throughout this essay that the production function is homogeneous of first degree, which means that \( \rho \) is a function of the labour:capital ratio alone.

8 Dots will in general indicate time rates of change. Subscripts will in general indicate differentiation with respect to the variable indicated.
capital ratio $\rho$ 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 $\dot{K}$, we can integrate (6) to obtain a solution in terms of $K$:

$$K = \frac{B - t}{U_t}.$$  \hfill (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 the difference between bliss and utility at $t$ to the marginal utility of consumption at $t$.

To give concreteness to (8), we shall adopt a specific form of the utility function, namely the constant elasticity function,

$$U_t = e^{-\alpha t}$$ \hfill (9)

where $\alpha$ and $\psi$ are positive constants.\(^\text{10}\) This function naturally suggests zero as the bliss-level, that is, $B = 0$. The marginal utility of consumption is given by

$$U_t = \psi e^{-\alpha t}$$ \hfill (10)

and (8) becomes

$$0 = \frac{\alpha e^{-\alpha t}}{\psi(\alpha - \alpha e^{-\alpha t})} C$$

\hfill (11)

Consumption plus savings are equal to total output, that is,

$$Y = C + K$$ \hfill (12)

In other words, the optimal saving rate $\dot{K}$ 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 $\rho$.

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

$$\frac{\dot{U}_t}{U_t} = (\alpha + 1) e^{-\alpha t}$$ \hfill (13)

by the marginal utility of consumption (10) gives the subjective rate of interest

$$r = \frac{\dot{U}_t}{U_t} = (\alpha + 1) e^{-\alpha t}.$$ \hfill (14)

It can be shown that $\alpha + 1$ is the negative of the elasticity of marginal utility, and $\dot{U}_t$ 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 over time. The subject of optimal saving is simply the product of equation (13) becomes

$$r = \frac{U_t}{t}$$ \hfill (15)

Since $r$ is fixed by tastes (those of society) and the planning commission, acting on behalf of society, implementation of the Fisherian balance, $\rho$, consists of choosing $K$ equal to $\dot{K}$.

B. SAVING AND DECISIONS EXPLICITLY RELATIVE

Now we can proceed to the last of the present inquiry, but not, unfortunately, without additional notation. Let $W_t$ represent the exogenously fixed wage, and let $\Lambda$ denote the labour capacity. Each value of $\Lambda$ is supposed to represent a different technique of production. The output capital ratio $\rho$ is a function of $\Lambda$ alone; in virtue of the assumption of a first degree homogenous production function,\(^\text{11}\) and we shall assume $\rho(\Lambda) = 1$ in our choice of the function. Assuming that all wages are consumed, we have the following function of $\Lambda$ and $\rho$:

$$\rho(\Lambda) = \rho(\Lambda) \rho(\Lambda) = \Lambda$$ \hfill (16)

In order to avoid mathematical complications we shall limit our attention here to capital accumulation
programmes in which \( \lambda \) and \( \alpha \), and hence \( \beta \) and \( \gamma \), are fixed once and for all at time zero.

One extreme solution to the present problem is to proceed as before, to choose \( \lambda_0 \) to maximize immediate output, that is, to maximize \( p \), but subject now to the constraint imposed by labour's insistence on consumption.

\[
p \to \lambda_0 (16)
\]

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 Holha Cherny. \(^{14}\) But it should be observed that in contrast to the SMP criterion was advanced was not one in which the rate of saving was linked to the choice of technique. Maximation of \( p \), 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 capacity. And precisely for this reason the criterion of maximizing \( p \) 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 saving ratio and the rate of growth of output and consumption seems clearly called for.

This suggests another extreme solution to choose \( \lambda_0 \) and \( \alpha_0 \) to maximize the rate of growth of output and consumption. This is indeed the criterion suggested by Walter Galenson and Harvey Leshem \(^{15}\) on the grounds that the maximal growth path will eventually provide more consumption than any alternative programme of capital accumulation. Maximation of the growth rate of clearly involves setting equal to the boundary value of unity and choosing \( \lambda_0 \) to satisfy the first order condition

\[
\frac{\partial \ln \lambda_0}{\partial \ln \alpha_0} = 0 \quad \text{or}
\lambda_0 = \alpha_0
\]

Maximization of the growth rate (which for \( \lambda = \alpha \) is equal to the investment surplus per unit of capital supplies) choosing \( \lambda_0 = \alpha_0 \) implies an equivalent productivity of labour with the wage \(^{16}\). Thus corresponds to the way of choice of \( \lambda_0 = \alpha_0 \) to maximize 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 missing the present in the future, regardless of how near the present may become relative to the

\[
\text{future in consequence, and regardless of how distant the future may be to which the present is connected.}
\]

Ma-race 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 \( \lambda_0 = \alpha_0 \) and \( \beta = \gamma \), 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

\[
\int_{c^0}^{c} -\Delta c^* \quad c^* > 0 \quad (9)
\]

Total utility \( U \) is given by

\[
U = \int_{0}^{\infty} \lambda(t) dt - \int_{0}^{\infty} \alpha(t) \lambda(t) dt \quad (18)
\]

With births taken as zero, Ramsey's objective of maximizing the integral of the difference between \( \lambda^* \) and \( \lambda \) is equivalent to maximization of \( U \).

Since we are combining our attention to consumption for all choice of \( \lambda_0, \alpha_0, \beta, \gamma \), and \( \lambda_0 \), we can substitute for the equations

\[
Y(t) = \lambda(t) \quad (2)
\]

the equations

\[
Y(t) = \lambda(t) + \lambda_0 \quad (3)
\]

Integration of expression (20) gives

\[
K(t) = K(0) e^{\lambda(t)} \quad (21)
\]

where \( K(0) \) is the given initial capital stock. This also gives

\[
K(t) = K(0) e^{\lambda(t)} \quad (22)
\]

in place of (19).

If we substitute the right hand side of (22) for the left in expression (19) we have

\[
U = \int_{0}^{\infty} \lambda(t) dt - \int_{0}^{\infty} \alpha(t) \lambda(t) dt \quad (23)
\]

After integrating and substituting an equivalent expression for \( \lambda(t) \) from (15), equation (23) becomes

\[
U = \int_{0}^{\infty} \alpha(t) \lambda(t) dt \quad (24)
\]

Maximization of \( U \) is equivalent to maximization of \( \log (U) \) or to maximization of \( \log (1/U) \), and thus last is the correct expression to work with. Now \( \log (1/U) \) is given by the equation

\[
\log (1/U) = \frac{\int_{0}^{\infty} \alpha(t) dt}{\int_{0}^{\infty} \lambda(t) dt} \quad (15)
\]

\( \lambda(t) \) and \( \alpha(t) \) are defined as the marginal productivity of labour in the absence of capital and the marginal productivity of labour in the absence of capital, respectively.
\[ V = \log \left( \frac{Y}{Y_0} \right) = \log a + \log \left( \frac{a}{p_0} \right) \]

\[ + r \log A(0) + \log r + \log a + \log (p - wA) \]  

(25)

Necessary conditions for maximisation of (25) are given by

\[ \frac{\partial V}{\partial a} = 0 \]  

\[ \frac{\partial V}{\partial A} = 0 \]

(26)

and

\[ \frac{\partial V}{\partial \rho} = 0 \]  

(27)

From (25) we have

\[ \frac{\partial V}{\partial a} = \frac{r(p - wA)}{a(p - wA)} + \frac{1}{a} \]

Thus (26) becomes

\[ \frac{\partial V}{\partial a} = \frac{1}{a} \]

(28)

Now combining (14) and (15) gives

\[ r = (1 + \rho)(p - wA) \]

(29)

so that (28) becomes

\[ \rho \geq \frac{1}{(1 + \rho)(p - wA)} \]

(30)

The derivative \[ \frac{\partial V}{\partial \rho} \] is given by

\[ \frac{\partial V}{\partial \rho} = \frac{1}{\rho} \left( \frac{a}{p - wA} \right) + \frac{\rho a w}{(p - wA)} \]

Thus equation (27) becomes

\[ p = \frac{\rho a w}{(1 + \rho)(p - wA)} + \frac{\rho a w}{p - wA} \]

(31)

Since the left-hand side of (32) is smaller than \( p \) when \( \rho = 0 \), and the right-hand side is greater than or equal to \( p \), the equality in (28) can hold only in the event \( \rho = 0 \), in which case (32) as well as (30) reduce to the Euler-Lagrange equation. (7), thus characterizes 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 \( \rho = 0 \), 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 a must equal unity, in other words, optimal growth requires reinvestment of all surpluses remaining after payment of the institutionally fixed wage bill \( wA \). In this case, the optimal technique is given by the value of \( A \), for which equation (33) holds

\[ p = r - \rho w \]

(33)

This equation is (31) with \( p \) 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,

\[ \left( \frac{\partial V}{\partial A} \right) \text{ employment const} \]

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,

\[ \left( \frac{\partial V}{\partial A} \right) \text{ const} \]

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. \[ p \]

(34)

For the optimal technique and savings rate the following inequality holds

\[ p > \rho w \]

(34)

Note that as \( \rho \) approaches zero, the \( V \) maximizing choice of \( A \) approaches the Calvin-Laschstein growth-maximizing choice, and the physical productivity of capital and subjective rate of interest approach the private rate of return to capital \( \gamma \). This implies \( r - \rho w = 0 \), hence from (33), \( p = w \), which implies maximisation of the rate of growth. A similar argument establishes that as \( \rho \to \infty \), the optimal choice of \( A \) approaches the SMP choice of \( A \) to equate \( p \) with \( w \) (unless a smaller value of \( A \) is driven to zero).

\[ \Delta \]

The shadow wage can be expressed in terms of \( \gamma \) by substituting in (34) an equivalent expression for \( A \) from (33). Thus substitution gives

\[ \gamma = \frac{p - \rho w}{r - \rho w} \]

(35)
If we momentarily change the ground rules, and assume that \( u \) is a parameter fixed exogenously rather than a chosen variable, equality between the subjective rate of interest and the physical productivity of capital no longer characterizes the socially optimal choice of technique. In this case, which corresponds to a mental 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 characterizes 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,

\[ \omega + (1-\alpha)p = \omega t \]

varies inversely with the capitalist propensity to save.

A numerical example might be useful in assessing the difference between optimization in terms of utility maximization and optimization 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.

\[ Y = L^{1/3} K^{1/3} = \lambda L^{1/3} K \]

so that

\[ \lambda = \frac{1}{\alpha} \]

Further, let \( \alpha = 2 \), and let \( \omega = 2 \). Then, the table below gives the values of the several variables associated with utility maximization and, for contrast, with maximization of immediate output and with maximization of the rate of growth.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Utility Maximization</th>
<th>Immediate Output</th>
<th>Rate of Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \omega )</td>
<td>0.25</td>
<td>0.173</td>
<td>0.0802</td>
</tr>
<tr>
<td>( \lambda )</td>
<td>2</td>
<td>0.444</td>
<td>0.24</td>
</tr>
<tr>
<td>( p )</td>
<td>0.01</td>
<td>0.016</td>
<td>0.3</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>2</td>
<td>12</td>
<td>2.93</td>
</tr>
<tr>
<td>( \omega / p )</td>
<td>0.025</td>
<td>0.038</td>
<td>0.128</td>
</tr>
<tr>
<td>( \omega / p )</td>
<td>0.038</td>
<td>0.038</td>
<td>0.575</td>
</tr>
</tbody>
</table>

*The value of \( \omega \) is irrelevant since \( \omega / p \) = 0.**

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 Y" for growth rates less than optimal; of which the "max \( \omega \)" 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 \( \omega \)" 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.

1. THE VALUE OF CAPITAL

In the economy of our model, output and consumption are governed by the simple relationship

\[ f(t) = \omega K(t) = \omega K(0)e^{-\omega t} \]

But suppose we relax that assumption slightly to allow the planning commission to be presented with the possibility of an alternative use of one unit of capital at time 0. The time pattern of consumption provided by the new opportunity, let us suppose, is given by the function \( \delta(T) \). \( T \leq t \leq \omega \). (This function is assumed to reflect reinvestment of surpluses over wage costs.) The choice facing the planner is whether or not to divert one unit of investment in the new option when the opportunity arises.

How might planners make these decisions? The first step is to compare the marginal utility afforded by the new opportunity 'homing' then marginal utility in \( U_A \). We can write

\[ U_A = \int_{t}^{t+1} \delta(t') dt' \]

where \( \delta(t) \) equals the marginal utility of consumption at time \( t = 0 \) and the virtue of the existence of the utility function.

The second step is to compare \( U_A \) with the marginal utility of investment at time \( t \), in the optimal technique as determined by \( v = p(\alpha) \) and \( v(\alpha) \). This marginal utility we denote \( U_{e,x} \). We have

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Figure 1

OUTPUT, WAGES AND INTEREST AS A FUNCTION OF PRODUCTION TECHNIQUE

\[ K(t_a) = \int U(t_a) \left( e^{\theta(t_a)} - 1 \right) \, dt + U(0) \left( 1 - e^{-\theta(t_a)} \right) \]

For the \( U \) maximizing choices of \( s \) and \( A \), substitution from (18) and (33) gives the equality

\[ V_{K(t_a)} - U_{K(t_a)} = \frac{\theta}{\omega - \rho} \]

New the same opportunity should be employed only if \( V_{\Delta} > U_{\Delta} \), or in other words, only if

\[ \left( 1 - e^{-\theta(t_a)} \right) > \frac{\theta}{\omega - \rho} \]

This criterion can be made a little more familiar by normalizing by means of division of (37) by \( U_{\Delta} = U_{\Delta} \), that is, by dividing both sides of (37) by the marginal utility of consumption at time \( t \). Then

\[ V_{\Delta} = \int_{\Delta}^{t_a} \theta(t_a) \, dt \]

(38)
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 (31) becomes

\[ \int T^* \Delta c(t) dt \quad (30) \]

The integral \( \int T^* \Delta c(t) dt \) is customarily called the present value at time \( t_0 \) of the consumption stream \( \Delta c(t) \) evaluated at the discount rate \( r \). Similarly

\[ C_n(\Delta c(t), t) \quad (31) \]

is the marginal present value of investment in the "optimal" technique. Thus (31) 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

\[ Y(t) = C(t) + K(t) \quad (3) \]

is usually, and we might therefore have expected that the new investment opportunity would be attractive provided its present value,

\[ \int T^* \Delta c(t) dt \quad (41) \]

exceeded units

But in the present model, limitations on the choice of \( x \) 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 this rate rather than the assumed that the present value of alternative
Figure 3

TIME PROFILE OF CONSUMPTION RESULTING FROM
UTILITY MAXIMIZATION AND FROM ALTERNATIVE
CRITERIA

\[
\int_0^1 \Delta(t) e^{r(t+1)} dt.
\]

must be compared.

The marginal present value of investment \( s/(r-p) \) is thus the shadow price of investment since in the present model average and marginal values coincide, \( s/(r-p) \) is also the shadow price of capital. This shadow price falls to unity only in the limiting case of \( p = 0 \) and \( r = 0 \); when the production function \( p(A) \), 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 \( U \) maximization dictates choosing \( A \) to provide a rate of growth of output and consumption that approaches the maximal feasible rate of growth, \( s \) goes to \( s \) 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 \( p = r \) 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-
Decentralised "market socialists" of a Lange-Lerner type could be guided to the \( U \)-maximizing choice of technique by an order from the planning commission to choose the technique of production to maximize the physical rate of return, \( p - \rho^* \), 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 \( \rho \) in choice of technique calculations amounts to an "as if" subsidy of \( w - \rho \) per unit of labour. Choice of the optimal technique could be achieved through payment of an actual subsidy of \( w - \rho \) 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.\(^{33}\)

The difficulty with decentralization 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 decentralized *tâtonnement* procedure. If \( \lambda \) is iteratively adjusted according to the formula

\[
\lambda^{n+1} - \lambda^n = -\theta (\lambda^n - \lambda^* \Lambda^n - r^n) \quad n = 1, 2, 3, \ldots \quad (42)
\]

where \( \rho^*, \rho^* \), and \( r^* \) are values associated with \( \lambda = \lambda^* \) and \( \theta \) is a positive constant then convergence...
of the sequence \( \{ A^n \} \) to an arbitrarily small neighbourhood of the optimal labour-capital ratio can be guaranteed by suitable choice of \( \theta \) regardless of the initial choice of \( \lambda \). 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 \( \rho \) and \( \rho_s \) would calculate the new value of \( \lambda \) from equation (42) and transmit the associated values of \( \rho \) and \( \lambda \) to the planning commission. This would in turn suggest a new value of \( \lambda \) 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 \( \lambda \) to maximize the output capital ratio \( \rho \). In this case the choice of a rate of saving \( s \) (which together with \( \rho \) 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 \( \lambda \) and \( \rho \) (beyond the point where the marginal productivity of labour \( \rho_s \) falls to the level of the wage rate \( w \)), the lower is the upper limit on \( s \). Others have explored the conflict between immediate output and the rate of growth that the dependence of \( s \) on \( \lambda \) poses, and it has been pointed out that in general the optimal technique can be expected to rest in a compromise between the marginal productivity of capital and the sum of the physical 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 \( \rho \) nor the private rate of return \( r = \rho \lambda \) 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:

\[
\rho = \rho \lambda + r \quad (33)
\]

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

\[
\rho \geq \rho = \rho \lambda + r > \rho = \rho \lambda \quad (34)
\]

The private rate of return \( \rho = \rho \lambda + r \) is equal to the rate of growth of output, consumption and employment, \( \rho_p \), provided all surpluses remaining after payment of wages are reinvested, 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 \( \rho_s = 0 \)) 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
one hand, and savings and growth, on the other, disappears. 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 $w - \mu$, with $\mu$ 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.

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 are commonly 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 be presented when starting with the assumption that the selected 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 problem of pricing in industrial project evaluation. It appeared that not very much could be said in this context about the policy approach to these problems. Yet because the computation approach leads 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 sacrifice. The general formula for such a comparison may be written, after Tinbergen:1

1 J. Tinbergen, "Project criteria", in Economic Planning
The Hague, 1963

* Planning Commission, Warsaw.
\[ \sum q'dx^t - \sum p'da_i^t = 0 \]

We denote here by \( dx^t \) the addition to each of the conceivable aim or target variables, \( a_i \) made by a project, while \( da_i \) stands for the quantities used of all the sacrifice (cost) items or factors \( a_i \). 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

\[ \sum q'dx^t = q'dx^1 + q'dx^2 + \cdots + q'dx^t \]

and the sacrifices being

\[ \sum p'da_i = p'da_1 + p'da_2 + \cdots + p'da_J \]

Finding these expressions is possible if, and only if, we can find (equilibrium) prices \( p \), for factors and \( q \) 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 \( q \) and \( a_i \) 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 practical 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 macro-economic 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 be 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 interconnection 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 interconnection 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-
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 fulfill 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 overall development programme. When using the previously introduced donations, we may present an overall development programme in the general form of:

\[ \Sigma q_i x_i = \max \]

subject to the condition \[ \Sigma h_{ij} x_i \leq a_j \]

and \[ x_i \geq 0 \]

where \( h_{ij} \) 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:

\[ \Sigma p_i a_i = \min \]

subject to the condition \[ \Sigma h_{ij} p_i \geq q_i \]

The solution of this dual programme gives the shadow prices of the factors \( p_i \).

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, \(^2\) 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 overall development programme, out of which the shadow prices were obtained. If its net result, per unit of sacrifice, is greater than zero (or \( x_i = 0 \) 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 item, 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 be due to the adopted simplification of the development programme.

3. Simplification with respect to \( y \)

As already stated, the technique of finding the shadow prices of a programme presupposes that the value parameters of the goal function are given. 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, irrespective of the branch of activity which they represent, would be directly comparable with one another by means of the adopted value parameters for aims and shadow prices for factors. Or, alternatively, it may mean that the cause of the difficulty involved in the use of the...


However, the problem is not as to whether the shadow prices thus derived may themselves affect the subsequent process of aim evaluation.
of investment. 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 former 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 \( X > A \), where \( X \) denotes the future net output of a given good and \( A \) 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 \( \Sigma g p x \) and confine our attention to those of evaluating the expression \( \Sigma f, d, \) more specifically, in finding the proper \( f, x \) 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 now, as 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 ascribed 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 \( x^j \)), subject to two constraints given by the available amounts of capital and labour. This can be written as follows:

\[
Z = \sum q^j x^j = \text{max}
\]

subject to

\[
\sum b^i x^j \leq l_i
\]

\[
\sum b^k x^j \leq K_k
\]

with

\[
x^j \geq 0
\]

From this, by writing the dual programme and finding its optimum solution, we can determine the values for \( dK \) and \( dL \) 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 \( dK \) 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 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 B-type programme would be most suitable for purposes other than purely theoretical ones. Moreover, the assumption of a given structure of the product form may be exactly the same as in the former case thev indicate an optimum rate of substitution between 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 prices of capital in terms of saving the labour outlay, that is, a rate of substitution of capital for labour. But the shadow prices, derived from the programme, are to be interpreted as rates of substitution between capital and labour for every kind of investment goods. Thus, we would have instead of one uniform rate, a set of rates, \( p_i \).

Using one uniform rate would mean that in the accounting formula for project evaluation the expression representing total cost would take the form:

\[
\sum_{i=1}^{m} p_i f_{x_i} K^{i-1} + 1
\]

where \( f_{x_i} \) is derived from the B-type programme, \( p_i \) is the shadow price of capital in terms of all other inputs, \( K^{i-1} \) would equal 1, and the whole expression would be simplified into \( f_{x_i} K^{i-1} + 1 \).

Similarly, with differentiated prices for various capital goods, the expression would take the form:

\[
\sum_{i=1}^{m} f_{x_i} K^{i-1} + 1
\]

where \( f_{x_i} \) represents the price of a capital good, \( K^{i-1} \) would equal 1, and the whole expression would be simplified into \( f_{x_i} K^{i-1} + 1 \).

It must, however, be noted that the B-type programme may, in certain cases, be treated as a substitute for the A-type, but on its own merits. In such cases the shadow price, derived from such a programme would preserve the full information, subject only to the simplifications of the programme itself and not having to be treated as a kind of substitute (end approximations) 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 prices of capital in terms of saving the labour outlay, that is, a rate of substitution of capital for labour. But the shadow prices, derived from the programme, are to be interpreted as rates of substitution between capital and labour for every kind of investment goods. Thus, we would have instead of one uniform rate, a set of rates, \( p_i \).

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Similarly, with differentiated prices for various capital goods, the expression would take the form:

\[
\sum_{i=1}^{m} f_{x_i} K^{i-1} + 1
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where \( f_{x_i} \) represents the price of a capital good, \( K^{i-1} \) would equal 1, and the whole expression would be simplified into \( f_{x_i} K^{i-1} + 1 \).

It must, however, be noted that the B-type programme may, in certain cases, be treated as a substitute for the A-type, but on its own merits. In such cases the shadow price, derived from such a programme would preserve the full information, subject only to the simplifications of the programme itself and not having to be treated as a kind of substitute (end approximations) to those derived from the A-type programme.
\( p_s \) is a shadow price of capital derived from the given development programme, while the question of finding all the \( p_s \) remains open. The practical solution is often to use market prices for the \( p_s \).

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 \( p_s \) and a uniform \( p_x \) and (b) by using differentiated \( p_x \) rates.

The former way seems more practical: there exists only one 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 the rule of substitution dominates the field of pricing in project evaluation. This means that in determining the way to be used the shape of the accounting formula should be clearly kept in mind and revised. This is sometimes overlooked by those who are anxious to stress unduly the role of the price structure in project evaluation.

Reference to the observations above make it necessary to note that to use an aggregated shadow price such as the \( p_x \) and a somewhat given \( p_s \) is not always sufficient. The solution of this problem is conditioned by a certain degree of interaction with market prices for the other effects to be taken into the balance. It is important that the set of prices be kept in mind in choosing the shadow price of the factors used in the formula (the accounting formula) as well as in choosing the relative sizes of the factors used in the accounting formula.

There is also no need to speak about the influence of other factors, such as differences in the cost of capital, on differences in the cost of capital, and on differences in the cost of capital.

The attempt may be observed in the following example:

There is no way of knowing the pretax return of cash flow to possibilities of using shadow prices in general.

The attempt may be observed all over the developing world to account for existing structure and changes in the framework for future economic development leading to a revaluation of the development plans. Obviously the governments or their planning agencies will aim as closely as possible at the notion of optimum programs.

So far, however, it has been impossible to build up a detailed and comprehensive methodology, which would enable us to proceed with the available information. Therefore, in practice, the value parameters that are to reflect certain development programmes can be no more than approximations to the ideal shadow prices that would be derived from a perfect overall programme. Among the causes, the following may be cited:

(a) The programmes (and, accordingly, the accounting formula) are simplified by disregarding some of the independent variables on both the benefits and the sacrifice sides.

(b) Production factors are aggregated into broad groups and simplified assumptions as to inter-factor substitution are adopted.

(c) The methods of computation are far from precise.

To distinguish between the approximations of 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" when reserving the term "shadow price" 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 beyond what may be called partial solutions. The other is that they represent aggregate value parameters which are often subject to the qualifications made above with respect to aggregate prices.

Something, however, may be said in defence of the aggregate value parameters, when they take the form of an average of accounting prices in abstract terms, that they were to be disaggregated according to the factors and time periods they would have to be annually adjusted. But the very procedure of current adjustment is rendered unnecessary in respect of approximations of a broadly aggregate nature.

It has been observed that despite the great potential efficiency of planning decisions made in the use of accounting prices, they have rarely been exploited in planning. 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 is 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 costly and time-consuming process. Finally, the application of accounting prices presupposes certain conditions of stability of the development projects. It has been observed that despite the great potential efficiency of planning decisions made in the use of accounting prices, they have rarely been exploited in planning. 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 is 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 costly and time-consuming process.
practical conditions as regards economic organisation and policy which are not easy to meet, and not easy to meet.

Notwithstanding these obstacles, and in the absence of detailed information that would be needed for setting up a comprehensive inter-industry programming framework, various methods are suggested of 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 overall 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 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 behavior of relevant planning authorities as regards the computation of accounting prices.

For example, it seems to be true that planners, if they use accounting prices at all, are anxious to compute the prices of those factors which are mainly in shortage. Thus there are countries which in certain branches, above all, are calculating the right to exchange, whereas others are only about the capital-interest rate and substrates primarily concerned about the wage rate. It is obvious that each of these approaches depends on the area of economic calculation, and for the present and future development of the economic system, the latter expresses itself also in the choice at times as a basis of the computation of accounting prices. A close relationship exists between the use of the accounting price and the picking-up process of approximate accounting prices. For instance, as a whole, or in the accounting price of a given sector, it can be picked up, and some actual prices may be backed against another. On the other hand, a centralization of economic policy is not primarily required that accounting price be used in the economic areas.

Although accounting prices, as we have seen, are only tentative, or not at all accurately applied in developing countries, there exist possibilities and growing belief in their economic experience and suggestions to further study.

It is beyond the scope of this paper to give a more adequate description, or a complete derivation of the main evolutionary development of the economic planning and general economic policy framework of the income and efficiency accounting price can be applied to practice. Mentioned by the economic literature of these economic partial sections, we refer to the other hand of all economic parameters of resources, not as capital, labor

and foreign exchange. Accounting prices of natural resources are not considered here, since they are computed in practice only sporadically.

1. **Input price of capital**

It is possible to distinguish three commonly used ways of calculating an accounting price of capital:

(a) The first is applying account of the existing market interest rates, adjusted rate of interest on capital. For instance, in the case of product rates of the central bank has been around 5 per cent, the interest rate charged by several banks ranges from 4 to 10 per cent, and mortgage interest rates charge 2 to 5 per cent at most. However, it appears that if interest rates and use of credit vary from case to case, the other hand interest rates outside the organized money market tend to be generally the same as those for deposit, with the only exception of productivity or capital. In such circumstances, the other hand interest rate and the rates applied to different transactions as compared with the above productivity or capital, can be the other hand the interest rate and the rates obtained in the other way.

(b) Another method is to assess capital stock which is included in the country's gross national product. It consists at least in two steps, one of which includes multiple currency calculation.

The marginal rate of productivity, or accounting price, is accounted for when determining the rate of return on capital. On the other hand, the capital productivity rate can be calculated from the marginal rate of productivity, or accounting price, or the rate of return on capital. Accounting price is included in the development program, or marginal on capital, or income, or resource.

(c) Last stage, the capital stock and the rate of return on capital are included in the development program, or marginal on capital, or income, or resource.
Generally, actual information will be most readily available on proposed government investments with a time horizon of 10 years. In addition, government projects are likely to include elements with relatively short time horizons and close to the present, while private enterprises will be able to work in the long term where government will undertake such projects. It is therefore understandable that actually profitable industrial projects are also preferred to investments in small-scale, short-term and management planning, and that calculation time interval existing in these projects as a result of the new method or that at present, while the above-mentioned method is proposed to be applied to these projects, it is still possible to construct the plan in order of increasing investment priority in terms of future production. This is one technique to construct such a plan. Obviously, the feasibility of technical solutions being developed is dependent on electric mix. We can assume that the current cost of production is stated in terms of labor only, and that there is no time lags between representing labor costs at production and at capital. The resulting investment income is then the difference between the present period of and the amount of saving in savings is the marginal period of recapture of the capital invested, assuming a given amount in terms of labor obtained annually.

This understanding would, of course, vary among different simplified models of criteria for project evaluation. Thus, it is commonly used methods of computation of an accounting period of capital cost because this method has been used in several countries for the same time, and secondly, it has been discarded in some interpretations explicitly from two forms of models.

Marginal recapture period represents the amount of capital invested in a given project and stands for the interest rate and for the annual cost of labor. From this, we may also write

\[ \frac{K}{T} \]

where \( K \) would mean the marginal period of recapture as used in the practice of socialist countries. It is obvious then that \( I \) is not a criterion for project evaluation, but a method of bringing capital to an equal denominator with labor only. It is a way of expressing the price of capital.

What may be misleading about it, however, is the very same term at the same time, and the study of the relations between the following two expressions:

\[ K_1 + I_1 > K_2 + I_2 \]

\[ I_1 < T \]

which may also be written as

\[ K_{1m} + I_1 = K_{2m} + I_2 \]

where $J$ is a standard rate of interest. Here we would tend to choose the variant with the same sum as the total of costs for $p$. 

A more direct way of looking at the differences is to find the relationship between the extra amount of capital needed to bring about a decrease in the labour cost. Let us denote this amount as $k$. 

$$k = \frac{A_1}{A_2} \frac{F_1}{F_2}$$

The above ratio may be interpreted for any pair of projects as the number of years in which the extra amount of capital $k$ is going to be repaid by the reduction in the annual cost of labour $F$. Hence it may be called the individual repayment period for project $P$ as compared with project $F$ and may be denoted here by $\tau$. 

It is easy to see that for any pair of projects the magnitude $F$ represents a rate of substitution between capital and labour. We may say that all the projects considered so many years are presented in such a way that the rate of substitution then necessarily given by the maximum acceptable rate which is determined by the existing constraints with respect to the available amounts of capital and labour. This maximum rate is not equal to the marginal cost of employment divided by $F$. Thus to choose a variant it is necessary to build the condition $\tau = 1$. In the sense that in this sense the period of repayment may be interpreted as a criterion for choosing investment projects. 

It is of some interest to note that the cost of interest rate is the period of the so-called standard repayment period. Commonly used in centrally planned economies varies within the range of 15 percent.

2. Level of wage.

It is well known that a major difficulty in estimating the accounting price of labour stems from the fact that labour is a much less homogenous and mobile factor than capital and institutions. Even with identical factors, the level of wages is an even more important source of perturbations in labour terms in the capital market. 

It is commonly admitted that because there are several categories of unskilled and skilled labor and their supply varies in different areas and at different times of the year, the only correct procedure would be to calculate the accounting price of labour separately for each one of the circumstances. Evidently there thus is no base for the average. 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 price of labour is a given wage rate, and in other countries the wage rate is to be calculated in the same way as in the capital market.

H.S. F. Proudest and H. A. (Jaworski et al.) have suggested a method of accounting for wage increases, which is based on the principle that wage increases should be accounted for in the same way as capital increases.

In regions of wage increases, the wage rates are to be multiplied by a factor greater than 1. 

In regions of decrease about supply, the wage rates are to be multiplied by a factor less than 1.

The determination of the repayment period in the accounting formula is to be given by the standard repayment period $\tau = F / \tau$. 

with respect to all the set of projects and the cost of social quality of labour. This approach may prove satisfactory in centrally planned economies with a relatively high level of labour. It is not always used in situations with obvious contrivance.
In a region of labour excess, \( T' \) is to be higher than \( T' = T \)

Both methods give the same results, as can be seen from the "basic" form of the accounting for foreign trade, commonly used in some centrally planned economies:

\[
\begin{align*}
\Delta I & = \Delta \text{investment outputs} \\
\Delta K & = \Delta \text{production costs} \\
\Delta F & = \Delta \text{output}
\end{align*}
\]

After \( \Delta I \), \( \Delta K \), \( \Delta F \)

II. Exchange Rates

Practical experience shows that the use of the accounting for foreign exchange for cost and return side substantially change the relative quantities of some industrial products.

One approach has been developed, which is understood to be a different situation to be maintained, the so-called "reconciliation period," and the accounting for foreign exchange. We confine ourselves to the following summary only a few of the most important and interesting methods of its computation.

First of all, the exchange rate which relies explicitly on a currency exchange rate to maintain the balance of payments equilibrium, the weighted average exchange rate and so on. This allows a number of considering questions in accounting for foreign exchange. The approach is particularly useful in a situation when the exchange rate can be set with some autonomy and subsidized the total amount of national currency. The exchange rate is set in such a way that there are reasonable gains in exchange reserves. This approach requires more complex action and a certain amount of preparation and developing a certain amount of important in the area of accounting for foreign exchange.

Another approach is based on the application of the accounting power period. This involves the use of the accounting foreign exchange rates and changing the intercountry trade balance in the period and that the corresponding action with that realized in which countries will determine the exchange rate in the period of no exchange.

According to this approach, the accounting for foreign exchange is divided into two periods in the two countries in the production of the relative variations in the exchange rates. For many countries, the opposite approach is difficult to find a suitable method of purposes of comparison, since one must bring with a certain normal stage in the currency accounts of payments. The price data are frequently neither adequate comprehensive nor sufficiently comparable and often take into account of the fact that even 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 commodities 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 (c.i.f.) 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 (i) the country itself produces and consumes one or a few commodities that make up a substantial part of the gross national product, (ii) these commodities are traded internationally but are not major imports or exports for the particular country, and (iii) there are no serious problems in comparing quality. Even so, the method for its 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

Finally, the extent of the necessary adjustment in the actual exchange rates can be obtained by looking at the variability of exports and imports, especially extremes. As an illustration of such an approach we shall more extensively the method presented in (ii). This method tends upon comparing the purchasing power of the monetary unit in export prices of the import prices of the country. In practice, and in the absence of better information, it can be varied at its market price and capital is imputed some rate of interest equal to the real marginal cost of foreign borrowing as relevant to the accepted government practice. In principle, one should then compare the implied cost of domestic resources per unit of exchange earnings. In this case, the latter is measured in domestic currency units rather than foreign currency units. The variation is then based on the purchasing power of the domestic currency in export prices.

Alternatively, if we assume that the commodity prices are seen to be foreign imports, present in the domestic foreign components with a given dollar cost in the foreign countries including raw materials, domestic and foreign economic equipment and the exchange rate expressed in terms of exchange rate, denote these by $F$.
### Division of Primary Inputs into Real Domestic and Imported Components

**Table for Computation**

<table>
<thead>
<tr>
<th></th>
<th>Domestic</th>
<th>Exchange</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Component</td>
<td>Component</td>
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<tr>
<td>Labor</td>
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<tr>
<td>Breakdown of Capital Stock</td>
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<td></td>
</tr>
<tr>
<td>$K_1$ - Imported Equipment</td>
<td>$0.10 K_1$</td>
<td>$0.10 K_1$</td>
<td>Based on import component of equipment share</td>
</tr>
<tr>
<td>$K_2$ - Domestic Equipment</td>
<td>$0.10 K_2$</td>
<td>$0.10 K_2$</td>
<td>Based on import component of equipment share</td>
</tr>
<tr>
<td>$K_3$ - Structures</td>
<td>$0.14 K_3$</td>
<td>$0.14 K_3$</td>
<td>Import component of structure branch</td>
</tr>
<tr>
<td>$K_4$ - Inventories</td>
<td>$0.20 K_4$</td>
<td>$0.20 K_4$</td>
<td>Import component of change in inventories in 1958</td>
</tr>
<tr>
<td>$K_1 + K_2 + K_3 + K_4 = Total Capital Stock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$K_5$</td>
<td>$K_5$</td>
<td>$K_5$</td>
<td>Reduction in inventory</td>
</tr>
</tbody>
</table>

Costs entering the probability calculation:

- $0.08 /K + K = Accounting profits 
- $0.08 K_5$ | $0.08 K_5$ | Based on the $K$ per cent profit assumption |
- $D_1$ | $D_1$ | Allocated according to total |
- $M$ | $M$ | |
- $C_a + C_b$ | $C_a + C_b$ | |
- $P_1 = D_1 + M$ | $P_1 = D_1 + M$ | |
- $G_a + G_b$ | $G_a + G_b$ | Total real cost |

Clearly, the depreciation rate of the two components of capital stock is the same, but the cost included in this probability assumption must be divided.

We here assume that the market price of labor reflects the cost involved.

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 ($C$), depreciation ($D$), remuneration of capital ($P$), and taxes net of subsidies ($T$). We have:

$$W + M + D + P + (T - S) = 1$$

Comparing this identity with total real social costs (domestic + foreign), as derived from the individual components in the above table, we obtain:

$$G_a + G_b = 0.08 K + K' + M + D + W + (T - S) - (P_a + 0.10 K + K')$$

In other words, the difference between total real social costs, as here defined, and total inputs (sources) as defined in the national accounts, taken in the subdivision of non-industrious taxes (which do not constitute true social costs such as the remuneration of capital where the latter is defined as the difference between the actual remuneration of capital and the imported $K$ percent), are we consider any such "surplus profit" as a transfer payment and not as a real cost item.

All we need now is to determine what the price of commodity in question would fetch on the foreign market. Denote this by $K_5$, which again in this case was evaluated in 1958 at the existing official exchange rate ($K_4$). The cost per unit of foreign exchange earned in that commodity is then found to be:

$$S = K_4 /S$$

For purposes of illustration, the measure was here worked out for a forty-page book, printed at the time of the economy in 1958, based on a market exchange rate in the same order of detail. For planning purposes, much greater detail would be required.

Yet another method of computation of the reselling price of foreign exchange was suggested in Poland by M. Kalicka and Z. Polak, the ex-
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:

1. The initial set of current market prices.
2. The expected set of market prices (which, of course, may not be uniform because of different price expectations of the individual decision-makers).
3. The real future set of market prices.

It is the divergence between (1) and (2) 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 all investment decisions are made by one central board in its practical investment decision-making.

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 overall development plan. The individual decision-makers are the bodies responsible for particular investment decisions. The difference between particular cases consists in the different endorsement of the central board in the matter of instruments for influencing the decisions of the individual decision-makers as to to make them conform with the overall strategy.

It may be safely assumed that, in any type of economy, the reason for preparing a development plan is to try to carry out, but this plan 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 overall strategy.

(b) Influening 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) "influence".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: 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 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 in 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 influence.

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, in the direction in which the inducement mechanism should work. Its absence in this particular respect depends on the institutional set-up of the economy.

Some leading countries have been subject to planned and mixed systems of production. Such that every process has served as a serious precedent for other in planning new ones. Thus, if a central influence is to be exerted, the problem discussed with project estimation and decision making is that of ensuring that the information received from the central board is adequate in its form and content. The information is treated at some length when discussing the characteristics of the central board. The main problem is the behavioral problem of the central board in the case where the central board is not a central unit of the decision-making process. In this case, the central board is not a central unit of the decision-making process.

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 setup of the economy. It seems helpful to distinguish two broad cases: the case of a "main decision-maker" and the case of the "resistant decision-maker".

By a "main decision-maker" we mean a low level projecting unit which has no reason 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 method of calculation. An obvious example of the "resistant decision-maker" would be the private business economic. This, however, is by no means the only possible example. The situation is rather inherent in a planned economy based on public property and state investment decisions, in a mixed economy where the public decision-maker may have its own goal, although differing from that of the private decision-maker, but making him to take steps for the information coming from the central board.

Let us consider first the case of the "resistant decision-maker". This case also seems to be institutional setting, where the central government of the public sectors, investment projects are planned. Special units of projecting agencies are entirely disinterested in the future performance of the new plant built according to their plans. Thus, the split between projecting work and future economic performance makes the projected information on the basis of any information coming from the central board to be entirely meaningless to the people who are more or less demonstrating it. The problem is not the necessity of a planned economy and a selective system of project evaluation, but the necessity of a method of accounting prices (shadow and accounting) in which the central board is not a central unit of the decision-making mechanism. The central board, which is instructed to act in the same way as the private enterprises, is not supposed to act on the basis of its own information but on the basis of that received from the central board. This reflects adequately the existing set-up of the development and the need to be general in defining any other later, such as current market prices, when we come to the end of the current market prices.
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. 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.
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 underemployment 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 classifica-
shadow price is the Lagrangian multiplier of the calculus of the values of the "dual" solution to the linear programming problem (see below, section 5.1).  

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 rate 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 suboptimizing 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 an reason to believe that the managers have any persistent bias leading to reduce their efficiency in doing this, one had better to make the managers formulate a theory of accounting profit. The incentive effects could be strengthened at the base of the manager were taken into account in calculating accounting prices. Suppose, for instance, that managers of building sites are paid not to utilize machinery sufficiently to maximize the accounting profit of the planners, it may be effective to lower the incentive profit of machinery to the site manager below the accounting price used by the planner.  

4 Economic or private prices  

The use of shadow prices in project evaluation where the making the assessment will not have responsibility for recurrent decisions poses several special problems. If one wishes to forecast the project costs and benefits of the project in each year must be estimated at approximate shadow prices. The value of the project assessed in this way will always be maximized 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 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 such shadow price of labour, we 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 2 and that none of this plant would be used on phase 2 if it were coated 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 stage of appraisal 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 the 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) returns 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 revenue, the nature of spillovers and externalities become blurred. It is nevertheless important that the effects on those not directly served by the project be taken into account. For example, a hydropower
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 certain 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 at which project outputs are 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 prices 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 the same product be sold by a large number of other producers but only that there are competing close substitutes and no price effect on entry into the product market. Thus a government fertilizer plant adding only slightly to national supply might generally take as its selling price 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.

### Intermediates

Projects often produce benefits which accrue to producers rather than directly to consumers. We may call these intermediate benefits to stress their similarities to the intermediate products of microeconomic theory. Four approaches to evaluating intermediate benefits may be distinguished.

#### (a) Market price paid for substitute 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 rationally 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 (b) below).

The social cost of substitutes already sold. A benefit distributed to a private producer 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 project service that is, the decrease in social cost due to market demand now being placed on the railways. Again this is suitable only to the extent that the new service does not provide more than real value for the old.

#### (b) Minimum cost of alternative input not already used

We are led naturally by the previous two approaches to ask if the project produces benefits which more than replace a new previous inputs or expenditures, how shall these extra benefits be valued? One possibility would be the minimum cost for which the firm 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 more suitable to provide the additional heat and power now obtained from the electricity. It may be emphasized that the above estimates the value of the additional electricity and should be considered as an appropriate measure of its value.

#### (c) Opportunity cost estimation

When the project outputs are used by firms not merely to replace a previous input but also to increase the output of the new may in some cases be possible to compute the total increase in output due to the additional input. Past experience in engineering or in the technology of a technically advanced industry may indicate the appropriate increase in the increased output of the product at the market price. Of course, this requires that all market prices at which this output is sold at the market prices at which these were sold.

### Consumer benefits

We now consider the methods of evaluating the price paid by the benefits which accrue to consumers. These include not only the actual products and services but also those benefits that individuals receive because of a project. For example, improved rail transport may benefit not only users but also those who will enjoy less congested roads. The issue
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 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 additional output. This is discussed in (c) and (d) below.

(b) Social cost of substitute 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 esciable 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 production not previously used. As already explained in paragraph 1, it is above an upper limit to the appropriate shadow price of a net increase of a good that can be obtained by measuring the lowest cost alternative method of providing the same consumer good or service.

(d) Willingness to pay (surplus method). In general, we try to shadow-pricing 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,DP, for shirts and shows the price (P_s) and output (N_s) 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_s) shirts? At price P_1 or P_s or some other price? Although P_s 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_1(N_1-N_s) overvalues the output while P_s(N_1-N_s) undervalues it. The appropriate value would be the entire shaded area under the demand curve between N_1 and N_s. If a simple shadow price were wanted, it would not be unreasonable to use an average of P_s 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_s), the use of the consumer surplus method to evaluate the entire N_1-N_s output would be inappropnate. Valuing marginal 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**

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The text contains a detailed discussion on methods of valuing public goods and services, focusing on the appropriate valuation of project outputs. It delves into the complexities of assigning shadow prices to goods produced, particularly when the good is sold in a competitive market and when the output is large enough to affect market prices. The text also emphasizes the importance of considering the consumers' willingness to pay, even in cases where the good is not sold to those who benefit from it. The diagram illustrates the concept of the demand curve and the valuation of project outputs using different methods. The discussion highlights the challenges and considerations involved in accurately evaluating the benefits of public projects, particularly in the context of goods and services that are sold in the market.
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 benefit may yield a much larger change in another type of benefit, the latter should therefore be evaluated at consumer surplus shadow prices. But this would still be inappropriate to extend the level of output beyond the point at which marginal consumer surplus exceeds marginal cost. As we have seen, in appropriate basic shadow prices can generally be estimated as an average of the before and after prices.

The demand curve estimation problem is more difficult if the benefits are not sold. Although the price

**Figure 2**

**NUMBER OF UNITS PRODUCED**

![Diagram showing price, cost, and consumer surplus per unit]
control, provision of medical services, and so on. The government may be required to provide medical services to all citizens, regardless of their ability to pay. In this case, the cost of medical services is funded by taxes or other sources of revenue. The government may also subsidize health insurance to make it more affordable for individuals and families. This can be done by providing tax credits or other incentives to individuals who purchase health insurance.

Another way in which the government may be involved in the provision of health care is through the regulation of health care providers. This can include setting standards for the quality of care, ensuring that providers are adequately trained, and enforcing regulations to prevent fraud and abuse.

In many countries, the government also plays a role in the funding of health care through the provision of public health services. These services may include immunization programs, health education, and disease prevention initiatives. Public health services are often funded through government budgets, and may be provided by local and regional health authorities.

The government may also be involved in the provision of health care through the use of price controls. Price controls are regulations that limit the ability of health care providers to charge high prices for their services. This can be done through the use of government price controls, or through the use of state-owned health care providers.

In conclusion, the government plays a critical role in the provision of health care by providing a wide range of services, funding health care providers, and regulating the health care market. The specific roles and responsibilities of the government will vary depending on the country and the health care system in place.

However, it is important to note that the government is not always the best or only solution for the provision of health care. In some cases, a market-based approach may be more effective, as it can provide incentives for providers to improve the quality of care and for consumers to choose the best providers for their needs.

The provision of health care is a complex issue, and the optimal solution will depend on a variety of factors, including the cultural and political context of the country, as well as the specific needs and preferences of the population. It is important to carefully consider the potential costs and benefits of different approaches before making decisions about the provision of health care.
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 incomparable 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 these benefits and costs to which shadow prices can be assigned, together with an enumeration of the incomparable physical benefits and costs associated with the project and a description of the expected intangible effects.

The presence of incomparable effects makes the final selection of projects more difficult. When the number of incomparables 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 incomparables 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 to others or other forms of disutility to individuals and transfer to them operating the project.

I. Direct Inputs

Resources used directly by a project should be valued at their social opportunity cost, that is, the alternative to the most productive use to which they would have been put.

When a public enterprise buys its inputs in a competitive market and does not have 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.

1. Government purchase allowing 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 would have paid as a discriminating monopolist. This type of situation may commonly arise in the hiring of labor for a major project. In figure 1, $y$ is the input supply curve. Without the input purchases required for the project, the total quantity sold of the input was $Q_i$ and the price was $P_i$. The project requires an input of $Q_2$, raising the market price to $P_2$. If $P_2$ 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 $P_2$ were used. The appropriate value on the resources in the entire shaded area under the supply curve—in effect the appropriate shadow price is weighted average of the prices between $P_i$ and $P_2$. For simplicity, if the price change is not great we might assume a linear supply curve and take the average of $P_i$ and $P_2$ 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 reduces prices to previous users as well as to the project. In this way the cost of holding price constant to the cost of rising price. Figure 4 shows supply

![Figure 1](image1)

**Figure 1**

**Quantity of input**

![Figure 2](image2)

**Figure 2**

**Quantity of input**
not $P_i(Q_0, Q_1)$, the shaded area. But this increased output has lowered the cost to previous users from $P_i$ to $P_i$. The saving in resources is therefore $P_i(Q_1) - P_i(Q_0)$. The appropriate shadow price is therefore $P_i(Q_1) - P_i(Q_0)$. What if the new lower price induces additional private users to purchase the good? Then the total output increases to $Q$. The total saving in resources consumed by the original purchasers is $P_i(Q_0)Q_0$. The total saved for the new private users $P_i(Q_1, Q)$, underestimates their value to the purchasers. The extent of underestimation is at most equal to the black triangle between the supply curve $P_i$ and the $P_i(Q_0, Q)$ segment. It would be at some of these private purchasers were willing to pay to pay a price above $P_i$. In this case, therefore, the marginal social cost that should be associated with the project's purchase of $(Q_0, Q)$ is $P_i(Q_0, Q) + P_i(Q_0, Q_1)$. The reader may note that the assumption that prices are corner firm marginal cost is important because if output prices exceed marginal cost, the project will be inefficient. In this case, the marginal social cost is the marginal cost of the project, which is the marginal cost of the project's purchase of the marginal product, minus the excess of the value of the marginal product minus the social cost of the project.

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 price for the total purchase of inputs.

(iii) unemployed resources. If there are unemployed resources, usually labor or land, 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 developing countries, or in periods of high unemployment. A not uncommon mistake is to measure the cost of otherwise unemployed labor 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 labor, it does not reflect the social opportunity cost of the labor. More generally, it is labor for hire, or being paid a wage for not exerting its marginal productivity, the marginal productivity of the employment. The wage should be taken as the social cost of taking away from its previous employment.

This rule should be applied in three ways. First, if it is possible to employ the “unemployed” resources, in some sense, more than the project, for instance, to stimulate employment by private producers, the productivity of labor in this alternative use and not zero, is the most appropriate shadow price. But even if it is possible to find productive employment for currently unemployed labor, the required action might be outside the control of the project administration. The relevant circumstance then requires taking the opportunity cost as zero.
appropriate to treat these expenses as part of the real rental cost of the labour. But although this 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 unem-
ployed labour, and the other is the traditional Keynesian case. The other is that the head, clothing and other items should be regarded not merely as necessary supplies to the worker, like books, 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 evaluations in favor of labor-intensive and vertically integrated projects. If unemployed labor can be used in producing intermediate goods for the project, these goods should be valued at a shadow price less than market price with the difference equal to the wage component of the otherwise unem-
ployed labour. All labour inputs, direct and in-
direct, 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 appro-
priate 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 otherwise might be expected to 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-expect prices.

2 Indirect social costs

A project may cause others to incur inconvenience, discomfort or expenditures. The shadow price appropriate to these indirect social costs ("external dis-
bursements") is the price that those whose welfare those would be willing to accept as compensation and feel neither worse off in the present.

Measurement is easiest when these 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.

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 most suffer the discomfort of airport noise. How much 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 provides an upper limit to the appropriate shadow price for that part of the noise that eliminated would be to use the cost of sound-proofing 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 homes 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 build-

ing of the airport or property would be willing to accept as full compensation if it were built.

D Shadow prices for indirect social costs

So far we have disregarded the problems of trans-
acency assuming that all benefits and costs were in the present. In practice the problems associated with the timing of benefits and costs are extremely im-
portant. Significant public investment increases or decreases in both the design and final decision stages require inter-temporal evaluations. Should we use a technique of production that requires large capital investment but has low operating costs, like example thermal generation of electric power, it would be appropriate. To produce a particular expenditure component of a power generation they preferred should we select a project with a constant stream of net benefits or on which produces few benefits in early years but greater benefits later. Should we postpone all or some of a particular investment, such as building a new road now and widening later.

Time affects our project evaluation in three ways. Changes in the market prices of inputs 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 hands used in the 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 income that may occur in all income over time can be ignored and all calculations made as if the current level of incomes remained unchanged. Not so for changes in relative prices. If some prices are likely to change relative to others, these should be reflected in the cost-benefit calculations. For example it would be unreasonable to ex-
pect that wages will continue to rise relative to the prices of manufactured goods and raw materials and so on. In calculating the future costs of a project this relative price change should be taken into account. Other goods may change in price because of changes in the demand for them. For example, to the introduction of new products or to a change in tastes brought on by higher standards of living or in their supply. And we consider changes in technology or cost regulations.

1 Social time preference

The first and most basic aspect of this problem is the measurement of the relative desirability of consumption in different eras. As individuals we prefer consumption in the near future to consumption in the more distant future. This preference may reflect an irrational bias in favor of the near future but it also corresponds to the more rational calculation that our incomes are rising and thus decreasing the significance of any given quantum of consumption and, secondly, that dearness
 difíciles de tomar decisiones sobre el uso óptimo del tiempo y del dinero. Sin embargo, el buen glosario de matrices y el conocimiento de las propiedades de matrices lineales es esencial para las operaciones de programación lineal.

La programación lineal es la técnica de optimización del costo o de la rentabilidad, que se basa en la teoría de matrices. La programación lineal es una herramienta poderosa para la planificación y la evaluación de los recursos. La programación lineal puede ser utilizada para determinar la optimización de la producción, la asignación de recursos, la distribución de la demanda y la planificación del inventario.

En el caso del sector productivo, la programación lineal permite determinar el óptimo en la producción, minimizando el costo o maximizando la rentabilidad. En el caso del sector financiero, la programación lineal permite determinar la optimización de la financiación, minimizando el costo de la financiación o maximizando la rentabilidad.

La programación lineal es una técnica que permite tomar decisiones basadas en una visión global de la problemática, tomando en cuenta todas sus dimensiones. La programación lineal permite optimizar la utilización de los recursos, asegurando una mejor distribución y una mayor productividad.

2. Enfoque de la solución

La solución de programas lineales es computacionalmente eficiente. Existen algoritmos y procedimientos que permiten resolver problemas de programación lineal en tiempo razonable. Sin embargo, la complejidad de los problemas que se pueden resolver aumenta con el tamaño del problema. Por lo tanto, la solución de programas lineales debe ser llevada a cabo de manera eficiente y eficaz.

La programación lineal es una técnica que permite tomar decisiones basadas en una visión global de la problemática, tomando en cuenta todas sus dimensiones. La programación lineal permite optimizar la utilización de los recursos, asegurando una mejor distribución y una mayor productividad.
important or expected indigenous non-tradeable resources. Labour and land should be shadow priced at their marginal productivity in the production of exports for import substitution at zero if they are unemployed. The calculation of marginal productivity may not be practicable in some economies. First in these economies, in which domestic market prices are meaningless on a basis for shadow price calculation (e.g. the developing countries), it may not be unreasonable to assume that the appropriate shadow price for labour is zero.

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 infeasible 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 income as well.

A problem arises in cases where the inputs to a particular project as initially defined include non-tradeable items such as electricity, transmission, or residential services, which have no import component. In these cases, it can be assumed that a certain amount of extra capacity will in general be obtained by building more roads or houses will be needed and this will have a shadow price, which should be added to the project as originally defined. In each case it is important only to have the appropriate extra cost in the project. The project may require an amount of electricity which it would be costly to generate but that purpose; if the plant can be located near other users of electricity, it may be the difference between the cost of 105 and 100 megawatt hours that is relevant, not the cost at a 5 megawatt station.

Similarly, if population and housing standards are given, there will be opportunity cost only if the import content of the development varies from site to site. It should be emphasized here that it is inappropriate 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 base 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. In the planners would be assumed to 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 independent of costs in fact to netted profits and domestic prices.

4 Further multiple factor shadow price

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 clear water, foreign exchange of specific raw materials, or labor supply. In such cases, an alternative is market location is the administrative allocation by the central planning agency to sub-agencies responsible for projects in particular fields. Expectation formation, efficiently, the central agency would have to know the value of each project as a whole in the next most productive use and so allocate funds. The central planning agency rather than a sufficient technical information base on this value itself. The administrative allocation involves arbitrary allocations of inputs to the sub-agencies. Each sub-agency would be to calculate an internal shadow price of the sub-projects in the way described for private capital projects. These internal shadow prices would be the result of project estimations in which particular inputs valued at external shadow prices had been the central agency.

The sub-agencies might note the presence of their unallocated resources and then negotiate an internal shadow price with agencies that have higher prices. After the negotiation, the central agency would then simultaneously determine the output and the price that would meet the requirements of the market and allocate the resources to the highest-bidder of the market. The shadow prices of the resources would be the same as the final price of the project.

This process might also be repeated at several levels, and agencies internal shadow prices become the result of an inter-allocative process in addition to particular plans.

The objective of the present analysis would probably be very different from what it would be if the government were to ensure an optimal allocation of natural resources in the question and the investment plans of the projects.


**Introduction**

The theme of this paper is the need for funds to carry on 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 corporation will serve as the vehicle for carrying out the industrial project.

The point of view in this article is that of a development financing organization. It is premised on the concept that development financing agencies of funds should lend as much more than in simple approximating or disapproving financing proposals prepared by a new industrial firm. If they are to be fully practicable and helpful, they should be giving and to serve as counsel at the development of funds for the new project, with particular emphasis on the 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 on business and financial management literature on the subject of financial forecasting for the new firm is relatively brief and general in nature. Hence the

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**XXI. APPROVAL OF NEW FINANCIAL NEEDS FOR NEW INVESTMENT PROJECTS**

**by Charles W. Williams**
numerous other detailed project calculations and financial forecasts provide evidence that the project will be economically viable. However, the forecast is only as good as the assumptions on which it is based. A major problem with the project is the uncertainty about how the new enterprise will fare in the market. The market could be highly competitive with strong established leaders, leaving little room for new entrants. The market could be on the cusp of change, offering new opportunities to those who are prepared to enter. The forecast must be flexible enough to accommodate these uncertainties.

The forecast should not only provide evidence that the new venture will be economically viable, but should also provide insights into the market conditions and potential challenges. This will enable the management to make informed decisions and adjust the plan as needed.

The financial forecast should be a dynamic document, reflecting changes in market conditions, economic indicators, and other factors that may impact the project. This will allow the management to make adjustments as necessary, ensuring the project remains on track and achieves its goals in an efficient and effective manner.
from the projected or programmed progress can be highly detrimental to the development plan of any agency, as well as to the enterprise's management.

A Consequence of Underestimation or Overestimation

A great many developments can affect the need for funds as the new industrial project moves into operation. Rarely do projects go exactly as planned according to plan of financial requirements proved to be precisely as forecast. 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 on the simplest form can result in the enterprise running out of money and credit and collapsing before the investments of the project have had a chance to show themselves. It is possible, however, that a large investment of money and equipment may so greatly extend the balance sheet that underestimation can lead to subsequent strangencies by the need for immediate funds.

One of the most important and advantageous uses of the balance sheet is the prediction of future requirements. One method for accomplishing this is the balance sheet forecast plan where a list of fixed assets is determined and associated with the balance sheet of the present period. It is usual to assume that the depreciation is a certain amount on certain assets, that the profit and loss of the enterprise will be shown by the balance sheet and that the gross investment of the enterprise is a source of credit. The necessary balance sheets for the business is then forecasted for the future period.

The balance sheet method of projecting future needs for capital, fixed and current, is one of the most important and advantageous uses of the balance sheet. The investment required in each of the key types of inventory, in accounts receivable, in plant equipment and spare parts is an operating cash and in any one important deviation from the forecast of the present period is based on the actual amount of current period funds available. This is indeed a useful method of framing the investment in a given project, and in showing the gross investment of the enterprise, or in showing the gross investment of a given period. The balance sheet program is constructed in such a manner as to avoid the need for a large amount of investment in either fixed or current assets. The balance sheet method is constructed to provide a clear and logical picture of the financial condition of the enterprise and to avoid the need for a large amount of investment in either fixed or current assets.
and managed by management of both the new enterprise and the financing agency.

2 Key Determinants of the Need for Major Assets

Finance 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 and economically sound and that the capital expenditures are sound ones. Commonly, capital expenditures are treated in amounts so that the management agency must be very important in clarifying the soundness of the capital commitment in a development project.

In certain degree the technology of the industry will be a consideration of the economic scale of operations will establish a reasonable needs for capital outlay on the project. Nevertheless, it is important not to include in the need for funds that is immaterial and beyond question that the requirement set forth represent the requirements of expenditures regarding the operations of the firm. Information about the productive capacity and the capital figures may well bring about alternative operating plans which will reduce the need for funds.

Two new industrial firms even in the same industry must be identified with identical needs. Nevertheless, it is necessary to identify certain requirements that are likely to be common to both firms that are not necessarily in each of the two cases identical. Among such asset category in some way is that permitted to do this.

In order to place in this discussion the assumption that the firm is small plastic product. In the initial years, the company will concentrate on the line of plastic injection molding of plastic material to be sold in the form of the standard products of the plastic film of telephone instruments.

A similar determination in the investment in fixed assets.

In the case of many industrial projects the technological side to the total, there are certain requirements for plant and equipment. Thus Progressive Plastics Inc. will certainly require certain compression molding machinery in which the charge of plastic material is heated under heat and pressure into the desired form. Additionally, certain grinding and polishing machines will be required to smooth and polish the rough product that comes from the mold. In this case, certain materials handling equipment and storage facilities will be necessary. And when the management decides to expand into the custom

monolithic of industrial products, additional machines, and buildings of the specific 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 is the firm is critical in deciding how large a productive unit should be. Since estimates of the 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 Inc. will require the production of molds to shape the distinctive pieces of dimension ware it will produce. If it desires to do its own mold 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 molds. Often the possibilities for farming out important parts of the production process are greater in relatively complex and highly developed economy 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 in investment commonly are importantly influenced by the degree to which the new enterprise finds it necessary or able to provide its own supporting infrastructure 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 is 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 Inc., ordinary factory buildings suitable for light industry should be sufficiently for its needs. And the environmental and warehouse area not only decide whether to rent or construct its own facilities might well be important. Similarly, the requirements for warehouse space may not be important in that it is also 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 testing and housing employees may be considerable. And decisions, therefore, very careful consideration. A related but different category is that of transportation facilities. The new enterprise might well consider the wisdom of using its own trucks or other transportation equipment as against the use of common carriers or contract carriers for the purpose.
facilities to be employed. The difference in outlook between "going first class" on major 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 complex 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

A one-size-fits-all inventory need is not projected by 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 equivalent to forty-five days' sales should be adequate for the firm's manufacturing industry. In circumstances where the new firm can expect to operate under conditions similar to those already in the field, the shortcut approach to forecasting, of drawing a ratio from the experience of established firms may prove satisfactory.

However, in a great many industries, the policies and circumstances of operation of different kinds vary substantially. Hence any average ratio for existing firms may have little relevance to the distinctive operation pattern of a particular new firm. The variety of conditions to be found in different countries and in different countries will present a 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 companies 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 requirements, 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 blindly prate from others, it is interesting to note that the inventory levels of all United States manufacturers at the end of March 1949 were equal to 60.8 days' sales at the rate of sales in the first quarter of 1948. The quality, from the overall averages of differing industry groups was substantial. This manufacturing experience in aircraft and aircraft parts was carried in inventories equal to 60 days' sales while manufacturers of machinery, motor vehicles, and transportation equipment and manufacturers of bakers products, and total inventories equal to only 12 days' sales. Doubtlessly, there is also a substantial variation between individual firms within the same industry.

What are the key factors that influence management's decision to carry inventories equal to sales of 40 days or 60 days? A number of key influences on determinants of inventory levels can be identified.

It is useful to divide inventories into two main classes, and consider the determinants of levels of each separately. In the case of finished goods manufacturers in a recent report to which I have access, inventories showed that the inventory of raw materials, work in process, and finished goods were roughly equal in value.

5. Key Determinants of the Accumulation of Inventories

First let us turn to raw materials. The need for investment in raw materials is

the anticipator taking of the manufacturing time, or the tendency to accumulate. If the rate of raw materials is not equal to the anticipated rate of sales.

The volume of safety stocks tends to protect against shortage, shortage, and to diminish the probability of interruption. The accumulation of materials will be related to the anticipated rate of sales.

The volume of raw materials makes it necessary to accumulate materials that are in the finished material. The accumulation of raw materials is not necessary and the rate of raw materials accumulation is related to the production needs to the time the firm has the ability of available stocks of the component parts.

A closely related consideration is the stability of availability of the flow of raw materials to the supplier. The cost of stock may vary directly with the probabilities of interruption or the fluctuation in inventory because of the secondary product of efficiency and a strike on transportation problems. For example, if the two hazards are encountered in maintaining the flexibility of inventory which must be industrial stocks, for example, where a large number of materials exist the probability of interruption due to change in government regulations in the stability of the availability of foreign exchange suggests the need for larger protective stock.

In particular, raw materials can be constituting the other and particularly the long term raw materials with inventory balances. In the case of an enterprise problem, the risk is highly sensitive to substitution difficulties. The practice of buying in a market which has a source of raw materials, not limited to the raw material, but also to a larger source.

A further consideration is the degree of finished goods stacks held by the firm. The experience of finished goods inventories and finished goods stock to the circumstances of the finished goods.

An analysis of a sample of industry in the year 1948 of the raw materials of the manufacturing industry in the United States, and a report of the Yearbook of the United States.
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.

6b. The extent to which the production process is continuous will also be important in determining the size of work in process inventories. For example, the aircraft manufacturer working on contract for 200 aircraft might well try to reduce production costs by making the whole of a certain 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 inventories. 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 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.

7. Determinants of the investment in finished goods

7a. 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 into the pattern of production. At the opposite extreme is the circumstance of the canner of peas who has ordered to hand the number of peaches precisely referred to who must produce his canned peas when the fresh fruit ripens. Very likely he will be able to sell over the entire year, consequently he must build up large stocks at the canning season and look forward to their gradual reduction over the calendar year.

7b. The competitive situation of the industry in the market will have a major influence on the need for finished inventories. Companies in a highly competitive marketing position characterized by excess demand may be able to carry limited stocks of finished goods yet not be badly hurt by occasional declines to fill orders promptly. However, in more competitive circumstances, the manufacturer will not wish to risk the loss of sales that might have otherwise been made had he not been out of stock.

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.

(4) 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.

(5) In industries or countries where sales are concentrated 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.

(6) 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.

II. 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' sales at the rate of sales achieved in the preceding quarter, it might be noted that the investment in receivables of all United States manufacturers on March 31, 1963, amounted to 40 days' sales. Thus, it might be noted that the investment in receivables of all United States manufacturers on March 31, 1963, amounted to 40 days' sales. The closeness with which the foregoing relationship on inventory and the permitted length of time for payment on receivables provides a material effect on the promptness of sales customers and hence on the level of outstanding receivables. Excessive credit, in addition to causing delays in the dispatch of shipments, will also cause customer complaints about the credit terms and to lower productivity in manufacturing as they think they can get away with it. These important delays in receiving payment from customers will cause the investment in receivables to rise.

(7) The degree to which production lags in the plant and in the office will have a significant impact on the level of investment in receivables. Defective and inaccurate paper work in receiving customers' orders in the maintenance of receivables records and follow-up procedures is important. Effective control and inspection procedures in the dispatch of critical shipments become especially important in accordance with which an over-shipment will lead to dispute and disputes on deferred payment.

(8) The most important determinant of the size of the outstanding receivables is the credit terms. If the terms are more lenient than those generally expected to be acceptable, the level of outstanding receivables is expected to rise directly with the volume of receivables. Thus, the more lenient the terms of credit, the higher the level of outstanding receivables. The terms of credit are a factor in the payment of receivables.

III. The need for cash

The new industrial firm must pay attention to cash on hand and to cash flow. One of the most important factors is the need for cash. In order to pay for raw material and manufacturing expenses, the firm must have adequate capital. In addition to cash on hand, the firm may finance its operations by borrowing funds from banks. The firm must also consider the effect of interest rates on the cost of borrowing.

(1) The investment in receivables is an essential part of the firm's financial management. Effective control of receivables will enable the firm to obtain prompt payment for its products and to manage its cash needs effectively. The firm must also consider the effect of the economy on the demand for its products and the competitive position of its products in the market.

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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 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 unproportionate 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 to 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 terms 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 covenant 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 frequent 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 unsettling. 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. J. 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 the 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 standby 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 decided 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 predominantly 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 would 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)

<table>
<thead>
<tr>
<th>Initial projection</th>
<th>Revised projection</th>
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<td>Cash</td>
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<td>Inventory:</td>
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<td>In-process</td>
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<td>Finished goods</td>
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<tr>
<td><strong>Total</strong></td>
<td>795</td>
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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, regardless 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 collections 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
experince 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 tenous 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, delays in production schedules once operations are underway, 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 equipment. The emphasis is on the same obstacles 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 the problem seems to be simply an 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 quickly 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. 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 sidestepped. Even when it is acknowledged, making wise and objective appraisals of future executives calls for subjective judgments, 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
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. 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.

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 normally 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 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 plant 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.

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 shall 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 fulfill 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 qualifications 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 fulfill 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 vitae 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 persist 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 organisation 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 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 available manpower. 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. 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 trainers/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 “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 consultant 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.
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 entreprenuers are likely to have quite different views about what makes a good executive. The civil servant quite naturally thinks of complex and proceduralized activities; the entreprenuer 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.
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 research 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.

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 research 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". 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, "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

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 questionnaires, 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); Électricité 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.

**Conclusion**

**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 analysis to reveal priorities within a developing country and prefeasibility studies to reveal alternatives.

The financial institutions complained of a shortage of worthwhile projects.

It is rare for corporations (companies and nationalized industries) to appraise 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 expenditure is more necessary.

**Footnotes**

Only about one third of the survey sample is defined as those with net assets of less than £30 million in the United Kingdom and France use discounting techniques to measure the NPV of industrial projects. The gap between theory and practice is larger, as is the gap between the best and worst practices. The largest American companies use more sophisticated methods, but the illegality of 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 the 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 distracted 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; these check lists will be helpful in this respect.

To discover the importance of variables by using sensitivity analysis and to concentrate attention on the critical variables.

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.

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 whenever 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 coordinate 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
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." 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. 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 almost certainly have 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, water resources and others, 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 inter-sectoral allocation of investment resources was made largely on the basis of political judgments.

Once, however, this inter-sectoral 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. 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) taking extreme measures of the comparative economies of various product groups and the relationship of cost to the price structure of such products. 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 local level (The search for opportunities)

The classical problem of economic planning is the allocation of scarce resources to competing ends and purposes.

The Economic Journal Vol 73, May 1963 also referred to a Royal Commission in June 1963. This study has been published as New Markets, New Methods and New Economic Policy, Oxford, North Western, University Press, 1964.


An excellent outline of a resource and demand analysis is given in Capital, a U.S. Department with the application to Latin America prepared by the Standard Research Institute, California for the International Co-operation Administration, June 1965.

See C. Foster and M. Morris, Estimating the social benefits of constructing an underground railway in London and others, 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 inter-sectoral allocation of investment resources was made largely on the basis of political judgments.

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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 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 independence 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 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.

4. Projects

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. Williams, however, in his study states that "the definiteness of planning was not... a guide to the efficiency of investment".

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'."

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". 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".

1. Mobilized 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 a 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, 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


Williams, Investment Decisions in French Industry, Paris: INSFAD (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 2,000,000.


arguments against spending during recessions emphasize the need for government inducements and action designed to reduce fluctuations in the business cycle. For even in the United States, where plans are generally longer, 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". 

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 seems 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 expenditure is delegated to a greater extent." 

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 channeling 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. Mr. Terbovich, reporting attending a conference where fourteen companies reported fourteen different methods of calculating this type of return. The two most common methods are:

The expected profit on net profit as a percentage of the average capital employed over the life of the project. This is often called the "book" method.

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:

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.

(v) "Postponability", "necessity" and other "non-documented" evaluations

The inadequacies of "lunch" 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.

(b) 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—i.e., it 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 investor's method (Hill and Gregory); rate of return (Fisher); discounted cash flow or DCF (Dean); and the marginal efficiency of capital (Kennedy). 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.

(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, 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 Akhain and Terborgh, and the "future method." 26

The IRR method suffers from two disadvantages. First, in certain cases it is possible to find more than one solution rate. Soper 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 viability.


worth, since the cost of capital\textsuperscript{10} 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:

<table>
<thead>
<tr>
<th>Method of appraisal</th>
<th>Number of companies using the method as a primary measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay-back</td>
<td>13</td>
</tr>
<tr>
<td>Book rate of return</td>
<td>18</td>
</tr>
<tr>
<td>Discounting methods</td>
<td>14</td>
</tr>
<tr>
<td>Number of companies analyse</td>
<td>45</td>
</tr>
<tr>
<td>Non-classifiable replies</td>
<td>32</td>
</tr>
</tbody>
</table>

*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:

<table>
<thead>
<tr>
<th>Method of investment appraisal</th>
<th>Number of companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay-back</td>
<td>9</td>
</tr>
<tr>
<td>Book rate of return</td>
<td>22</td>
</tr>
<tr>
<td>Discounting methods</td>
<td>9</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
</tbody>
</table>

The size of companies was defined as follows:

- 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\textsuperscript{11} 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 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."\textsuperscript{22}

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 questionnaire that they were using discounting methods did not in fact use such methods correctly (see section 4). 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 much in error. Bruce Williams\textsuperscript{12} 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 goods; because the factors 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 the


\textsuperscript{10} 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.

\textsuperscript{11} See (a) *Thresholds and Sleepers, PEP (Political and Economic Planning)*, London, Allen & Unwin, 1965, a survey of forty-seven small firms in six industries. (b) *R. N. Will, Replacement Policy, NIER (National Industrial Equipment Reserve)*, November 1964, a survey conducted among participants in a conference held by the Production Engineering

\textsuperscript{22} See footnote 32 (k) 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. 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." 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 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. 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 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 6 to 8 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 objectives 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. 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. In order to avoid misinterpretations 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 method. One company claiming to use the net present value method stated that it deducted depreciation from

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84 See the Financial and Economic Obligations of the Nationalized Industries ( Cmd 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 to be regarded as social services absorbed from economic and commercial justification".
85 Vol 1, June 1964, p 103.
87 The Treasury has prepared an excellent booklet (unpublished) to provide further thought on the subject: Appraisal of nationalized industry investment projects.
88 Calculated on an internal rate of return basis.
89 To implement the policy set out in the White Paper (Cmd 1337), five-year financial objectives were agreed with most of the industries concerning the money cost of capital.
90 A 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 nationalized industry investment projects": see footnote 38 above).
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 rank 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".43

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, France 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".44 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".45

United States of America

In Topics of Cost Accounting and Decisions, Bierman states that "in fact, this (cash payback) is the most common method in use at the time this book is being written".46 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".47

In a survey of 127 American companies reported in the NAA (National Association of Accountants) Bulletin of June 1940, 116 were found to have used some form of return: 66 had used payback, 59 the book RR and 38 one of discounting techniques. Professor Blockie and Grey, in a survey of fifty-seven large American manufacturers' investment, found that 85 per cent of the respondents used some form of payback 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".48

Fisher found that the average return on initial cost was commonly used for major as well as minor investment and he expressed distress that the club of American businessmen used this "crude" formulation of the rate of return.49

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43 Investment Decisions in French Industry (see footnote 1 above).
45 Political and Economic Planning (see footnote 1 above).
In Istvan’s more recent survey of forty-eight companies, 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).

<table>
<thead>
<tr>
<th>Method of investment appraisal</th>
<th>Primary measure</th>
<th>Secondary measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCF (including the MAPI formula)</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Book RR</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>PB</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td></td>
</tr>
</tbody>
</table>

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.” De Chazeau also finds “stubborn resistance of businessmen to scientific economic formulae for the timing of capital outlays” and Gott 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.

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.” Separation here means the divorce of ownership from control.

Norman F. Pfann 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.”

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

Timbergen’s has pointed out three respects in which the appraisal of a proposal’s worth to the community differs from the appraisal from the viewpoint of the individual firm. 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 computed. 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, rather than to any particular factor. The evaluation is therefore calculated in terms of the social rate of return.

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. A social accounting matrix (SAM) of the British economy has been prepared by Richard Stone and his colleagues at the University of Cambridge, England. 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...
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 forward linkages 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."45 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".46 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 "popular companies" in various territories and, for the guidance of such companies, a checklist 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 checklist 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 is the alternative use of resources which is the prime consideration. Some weight is also given to the promotion of exports, 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
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 constraints; the future ("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 connection 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" sets out the requirements of § 611 of the Foreign Assistance Act of 1961 and §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, 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). 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. 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.  

64 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 Clevel Harral and Tillo E. Kuhn of the Brookings Institution, 1965 (unpublished); see pages 191-193 for other criticisms.

65 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 coordinated 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 IBRD (for Colombia and Nigeria) aim at bringing actual and potential donors together to consider the development efforts and external assistance needed for a specific recipient country. For details of other co-ordinating arrangements among aid donors, see the 1966 review of "Development assistance efforts and policies" published by OECD.

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. 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 is generally used in the appraisal of a project, although discounting techniques are used for irrigation projects."

"There is usually an incentive to invest in infrastructure projects because of 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 expediency. 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.

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." So states Mark Abrams. An expenditure of £15 million a year, 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."

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 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 project 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 profitability of projects are not assessed at all (see section B-1)....

72 See James A. Lynn. The Application of Investment Criteria in a Development Bank, Tomas del VIIApril 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 S101 of the 1963 Foreign Aid Appropriations Act, cost-benefit studies are required for water or related land-use projects.
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 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 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 applied the present ratio of current-to-fixed assets to project estimates, and one company stated that credit received from suppliers was ignored. 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 tax 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" that might arise from investment allowances. In fact, comparing the various surveys 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 rare, 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. 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 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 of 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 companies.

10. B. Edwards, "The replacement of obsolete plant," Economic Journal, August 1961. It, however, is not the case that it is invested as greater than the amount required to meet demand (the difference is known as "national capital") and would normally be sanctioned only if it could show a return of about 10 per cent (about 20 per cent growth) (see "Report from the Select Committee on Nationalized Industries," House of Commons Papers 267, 1 May 1963).

11. The distinction between replacement and expansion projects is in this arbitrary sense, but, as stated in section A, it is normally 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." 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 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 1984 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. When attempting to forecast the total demand for coal, the elasticity of price and income were assumed to be constant and in the same order of magnitude as the own price elasticity of 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.

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 market order of other stations.

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.

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. However, it is not only a presumption since the number of companies interviewed was too small to give good grounds for generalization. And the published surveys generally ignore the methods used to arrive at data which form the basis for the project appraisal. However, the three companies interviewed stated that, when collecting information for appraising projects involving an output of more than $25 million, very detailed analyses were usually made. These analyses involve the study of market structure, trends, and the role of competitors in the market, but no copies were made available. All three companies used petroleum economic analysts, and one company stated that they often employed consultants to carry out market and technical studies, especially for overseas projects.

A management consultant in New York stated that large American companies identified a shift in sales with sales surges above $300 million and were very conscious of the need to check on market information, and he knew of at least twelve companies which had special project teams whose responsibilities included not merely the appraisal of projects but the complete planning of expansion and the initiation of the project. When the interviewer pointed out that, compared to French companies, there seemed to be a greater awareness among the three large American companies of the need to check on market information behind a project proposal, the consultant said that he thought that this would lead to a greater use of probability techniques and more analyses by American companies.

The three companies interviewed stated that working capital and start up costs were always needed, although how precise such estimates were depended on the relative importance and detail of the project. The total project cost the companies stated that the estimations were included in the proposal. When investigating overseas projects, there seemed to be a tendency in the appraisal of a project which the single-potential companies follow since the world market project has been revealed.

The three companies interviewed in New York stated that they used market potential studies to determine where the market for petrochemical products could be found outside the United States, and that the companies used market studies to determine which agents would be needed to distribute the product. One of the companies indicated that, in order to assess the market potential and the market share, the companies' engineers went abroad to visit companies with a view to getting a general understanding of the potential market and of the development banks. Government agencies, such as the Federal Reserve Bank of New York, revealed the potential of the market, and the companies' engineers went abroad to visit companies to determine the market potential and to get a general understanding of the development banks.

The three companies interviewed in New York stated that they used the probability techniques to assess the market potential and to get a general understanding of the development banks. Government agencies, such as the Federal Reserve Bank of New York, revealed the potential of the market, and the companies' engineers went abroad to visit companies to determine the market potential and to get a general understanding of the development banks.
First, a study of the overall investment 'climate' 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 exploitation 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 an fact estimated and included as a cash flow in the year in which it is expected to be incurred.

2. Common misconceptions

One 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 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 on profits should not be attributed to the project. The comparison should be conducted in terms of what will happen with and without the project.

The importance of the investment climate is stressed by both, up to 25% factor costs. This study is currently being conducted by the investment climate in a number of developing countries by the Business and Industry Advisory Committee (BIC).


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.

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 market and 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.

The agencies stated that they used check lists so that first information was received on the forms in which it was received, and secondly, common pitfalls were avoided. Some of these check lists have been referred to in section 2, 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 of your opinions are the variables for which estimates are most commonly incorrect?" (BID, AID and OECD gave capital costs and in particular, costs of non-manufacturing facilities, estimates of working capital and pre-production expenses, and gestation periods. It was thought that the use of check lists feasibility studies, and comparisons with pre-investment studies would improve the accuracy of these forecasts.

4. Common misconceptions

Some of the mistakes made in project by opponents 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
project should be ignored. Taxes, especially in developing countries, may perform a very useful function and be "social savings." Nevertheless, they should not be considered as a direct economic benefit allocable 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 a 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 fixed 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 III, it should be valued at its marginal opportunity costs.

Sometimes, when foreign exchange has been scarce, it has been rationed to projects to the postponement of them all. A better course would have been to abandon some of the least worth while projects.

"Flash" measured by IRRD was the emergence of extra capacity through "sparking." With the lack of innovatory capacity and the attraction of high profit there has been a tendency in some developing countries to mislead successful enterprises. Reference was made to Saudi Arabia in this respect.

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 projects. In fact, however, there is a considerable amount of uncertainty in any forecast and a certain degree of uncertainty in many projects. hese uncertainties are generally distinguishable between risk and uncertainty, but some few organizations have made the distinction, the two will be treated together under the collective title of uncertainties.

In 1957 Roberts stated that "the most serious defects in the present state of knowledge about capital budgeting are the absence of a satisfactory framework for measuring uncertainties and the absence of a systematic and certain risk analysis in any project. Because of the uncertainty the data is otherwise unavailable and since 1957 much has been written on the subject although few definite conclusions have been drawn from the analysis.

Basaically, there seem to be two main methods of measuring the impact of uncertainty on a project. These are

The subjective method that is the degree of risk assessed by the board of the company.

Classification into field type projects and classified according to their risk characteristics. A higher or lower financial return is required for each risk grouping.

Minmax: the method was developed by Wild, Statistical Decision Theory, New York, Wiles. The minmax analysis maximizes the minimum gain or loss that can result from a given project. The project then presents the decision maker to choose that project which will lead to the minimum loss in the event of adverse circumstances.

Probability theory's various methods attempt to attach probabilities to ranges of outcomes thereby presenting the decision maker 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. The board or decision taker to see the effect on the worth of variations in sales levels, price levels and output ratios of capital cost, etc.

H. B. Robinson and the authors agree that the approach is suitable for investment decision making companies and it is often at large number turning ignorance into knowledge we are using in a kind of uncertainty analysis. This is also true of ignorance.

The most suitable form of analysis will probably be two way. In order to show the uncertainty from the total failure of the project capital budgeting analysis showing the percentage of value retained through time will be appropriate. On the other hand, in order to show the effect of fluctuations in the cost of output to profit, the model under which such data information is required is sensitivity analysis and generally he must apply it. However, as a result of such an analysis, it is not possible that the price of a material, or a stock of a material, interest may be worth while trying to supply. On this contract, guarantee the price of the materials in order to reduce the risk of the project. A sensitivity analysis can be used to indicate how the information allows a good decision. On the other hand, to make the decision worthwhile.

In summary, the authors have believed that the organizations in Europe and the United States where the authors are located and are using the following:

H. B. Robinson Investment Analysis for Developing Countries AB "The Copper Project" New York, Wiles.
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 assigning quantitative per-
centages to major factors and evaluating the results
with the upper and lower confidence limits used.
We have a company model expressed in the form of
a computer programme. This enables many possibili-
ties 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,
exports and imports of various types of fuel. Com-
panies stated that they had used it in conjunction
with overseas investements to determine the minimum
price for a contract, or tax allowances from a Govern-
ment, 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 probability
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 cus-
tomers, suppliers or the Government, and would
reveal the "critical" variables to be further inves-
tigated. Attention could then be directed towards
unearthing more information, or discovering methods
of reducing risk arising from fluctuations in such

A number of the companies and organisations
using sensitivity analysis have prepared computer
programmes for calculating the worth of an invest-
ment and a mere few seconds of the computer's time
are required to calculate the effect of a change in
either of the variables108. However, as the Courtauld's
manual points out, "variations on the
mean underlying assumptions made for the project
does not necessitate complete re-calculation of
the DCF return". 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

pipeline projects by computer" for a reference to the use of analogue
calculators in DCF analysis.

109 Alfred and Evans, op. cit. note footnote 24 above, p. 28.
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 is "tied up" in the project, there is high value in alternative uses (for example, if re-sold), 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 payback method in the assessment of risk because of its failure to measure the return on the capital at risk 106.

The American companies interviewed all used some form of probability or maximin 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 projects. For example, some risks could be insured against 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 probability of the project.

**IV. 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 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 motivation 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.

**I. 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; thus 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 control, we make a practice of having a formal month review with the production of cost control sheet showing the various items as in the estimate and an up to date revised anticipated total 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 that all possible the balance 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 107 to control the costs. All three companies in the United States stated that they used network analysis to 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 requirement on the knowledge of due dates from quotations etc. results in forecasting requirements to actually required. Each 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 favor tax key contracts 108.


107 One agency stated that it sometimes insured against the reversion of its loan through local currency inflation by requiring that repayments would be made in dollars.

108 The critical path method (CPM) was devised by the Central Electronics Research and Development Laboratories in the United States in 1956. In 1968 a similar system was adopted in the United States, where it has been particularly successful in planning the design and manufacture of missiles. The use of these techniques is said to have shortened the design process by more than two years. Variants of CPM such as programme evaluation and review technique (PERT) and resource allocation and multi product scheduling (AMPs) have been developed and in various forms is used by a number of companies in the United Kingdom. Some companies have found applications for remote operations, project control, a path and its efficient use being critical (Brainerd, A. et al., *Electronics and Control in the United Kingdom and France*, 1973).
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". This would seem to be confirmed by the Smith and Kenmers' 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 have 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. HRID 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.

HRID 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, HRID states in its booklet Some Techniques of Development Lending: "Experience shows that at least for a leader 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."

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:

<table>
<thead>
<tr>
<th>Number of companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>No post-mortems on individual projects</td>
</tr>
<tr>
<td>Post-mortems on &quot;most large projects&quot;</td>
</tr>
<tr>
<td>Other answers: &quot;post-mortems in the early days of production&quot;, &quot;on samples of projects&quot;, etc</td>
</tr>
<tr>
<td>Non-classifiable</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

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 in America 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. 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 "bed 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 Kenmers' 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 post-projects the profitability of the most important projects, and find out the reasons for any discrepancies."

81 [Istvan] A Study of Capital Expenditure (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.\footnote{110}

It seems from the postal survey and interviews\footnote{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 at 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-mortems 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.

\textbf{APPENDIX I}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
\textbf{Year} & \textbf{4} & \textbf{6} & \textbf{8} & \textbf{10} & \textbf{12} & \textbf{14} & \textbf{16} & \textbf{18} \\
\hline
1 & 96 & 94 & 93 & 91 & 89 & 86 & 83 & 80 \\
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 \\
\hline
\end{tabular}
\caption{Present value of £1}
\end{table}

\[ \text{PV} = \frac{1}{(1 + r)^n} \]  
 \text{--- to determine the present value of future cash flows.}

\textbf{APPENDIX 2}

\textbf{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.

\begin{itemize}
\item \textbf{A Market}
  \begin{itemize}
  \item 1 General business standing, bankers' references, firm & ex-
  \item 2 Are any political objections to the sponsors likely from government, governing party, trade union, etc?
  \item 3 If sponsors are a company or partnership, what is paid up capital?
\end{itemize}
\end{itemize}
(h) 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. Viability
1. Past or present experience with the type of project proposed.
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.
7. Pre-emption rights.
8. Insurance.
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 five 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.
2. Modes of latest capital acquisition.
   List of principal stockholders, with information concerning their share in the company's capital.
3. Audited balance sheets, operational accounts, profit- and-loss accounts, statements of distribution of profits (for past five financial years).
5. Detailed analysis of last certified balance sheet and financial statement.
   Description and breakdown of principal assets.
   Explanation of changes in those assets.
   Short-, medium- and long-term credits already obtained by the company and terms (rates, repayment modalities, security offered).

*Submitted in French.
Details of market value of fixed assets, plant and stock.

Preferred claims on the company and commitments undertaken by it, particularly in the form of performance bonds.

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.


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 shareholders, 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 country, 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, interests 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

<table>
<thead>
<tr>
<th></th>
<th>First year operations</th>
<th>Second year operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash receipts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paid in equity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppliers' credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-term debt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-term loans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in accounts payable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### B. Projected Cash Flow (continued)

<table>
<thead>
<tr>
<th>Construction and start-up period 1-2 months</th>
<th>First year operations</th>
<th>Second year operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in sundry current liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net profit after taxe:s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add back:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-cash charges occurring before</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net profit after taxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserve for bad debts</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL CASH RECEIPTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital expenditures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debt repayment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-term loans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-term debt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppliers’ credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory increases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in accounts receivable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in sundry current assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividends</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL CASH DISBURSEMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net cash generated during period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulated cash position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### C. Profit and Loss Projection

<table>
<thead>
<tr>
<th>Construction and start-up period 1-2 months</th>
<th>First year operations</th>
<th>Second year operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net sales</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: Cost of goods sold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation of plant and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gross revenue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: Selling, general and administrative expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net operating income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: Interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous charges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repatriation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management fees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sundry taxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserve for bad debts</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net profit before taxes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: Income taxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net profit after taxes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal and other reserves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net available to stockholders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividends</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>To realize surplus</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### APPENDIX 3

**ECONOMIC AND TECHNICAL BOUNDS ANAYLSIS IN INDUSTRIAL PROJECTS**

(Plants for production or processing of commodities or manufacture of products such as cement, steel, fertiliser, 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 feasibility of the particular undertaking.)

(For a detailed discussion of a step-by-step procedure for developing an industrial-type project, encompassing all technical and economic feasibility and estimating both its commercial...)

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and national economic profitability, the reader is referred to<br>Industrial Development — A Guide for Accelerating Eco-<br>Nomic Growth, by Murray D. Beyer, New York, McGraw-<br>Hill, 1968. Copies of this book will be available to all<br>United States AID missions, for the use of applicants for<br>AID financing.)

1. Summary

Type of plant and kind and quantities of commodities to<br>be produced.

Location, illustrated by map showing surroundings and<br>site in with transportation facilities and existing utilities.

Distances to sources of supplies and raw materials and<br>to markets.

Relation of project to applicant's present operations, if<br>any. Benefits, cost and profitability.

Reference to any applicable reports (attached or readily<br>available elsewhere).

2. Commercial economic aspects

(a) Markets

Local or regional market trends during past five years<br>for each major product and any closely related products,<br>tabulated to show:

Domestic production, imports and exports; net local<br>consumption, and anticipated development of the local<br>market.

Present per capita consumption in country, and comparison<br>with other countries.

Local laws, regulations or customs affecting marketing of<br>proposed products, including import and export duties,<br>tariffs, quotas, restrictions and subsidies.

If part of proposed production is intended for export,<br>show for each major product

Number of units expected to be exported; proposed<br>markets and costs of transport and import duties.

(b) Applicant's present operations, if any

Description of present operations, including those of sub-<br>subsidiaries or parent companies.

Complete financial statements, including balance sheets,<br>profit and loss statements and dividends paid for past<br>five years (see annexes C, D, and E; annual reports are<br>usually acceptable in place of annex C if reasonably<br>equivalent information is given).

Present production capacity for each product

Sales volume and value of each product for past five<br>years, showing separate figures for domestic and export<br>sales.

Domestic and export prices, fob plant for past five years.

Estimated production of each major product in present<br>plant for next five years.

Estimated additional production required to meet overall<br>demand for next five years including intended exports

(c) Competitors

Names, location, present and future output, production<br>costs and selling prices of present local competitors on<br>the same field of production.

Information as to any anticipated changes in competition<br>such as expansion, modernization, new plants, new com-<br>peting products, etc.

Information as to foreign competition and any anticipated<br>changes in laws or regulations which might affect volume<br>of imports.

(d) Competition position

Selling prices to be met in domestic and export markets.<br>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<br>quality of raw materials; efficiency of modern productive<br>equipment and processes; quality of products; dependability<br>of supply to consumers.

(e) Summary of commercial prospects

Schedule showing forecast of sales volume for the domes-<br>tic market and each export market, and percentage of<br>total market claimed in each case, with full explanation<br>and justifications.

Justification of proposed capacity of plant to be con-<br>structed.

3. Engineering aspects and technical soundness

(a) Design

Plant lay-out, including storage for raw materials and<br>finished products and provision for possible expansion<br>Tie-in with transportation systems

Type and size of major installed equipment and<br>structures, and justification of the selection of units and<br>processes. (Avoid both obsolete and experimental tech-<br>nology.)

Function performed by each major unit

Process flow sheet

Auxiliary capital equipment (standby, spare parts, trans-<br>port, materials handling, etc.)

Patents and licences involved.

Planned capacity and buildup of output after start up.<br>Estimated output at percentage of plant capacity for each<br>of first five years of operation.

Anticipated use of consultants on special phases of total<br>project design.

(b) Utilities available or to be provided

Requirements, source, availability, cost, and reliability of<br>all utilities. Pertinent data on each system, and reason for<br>selection of source in each case including comparison at<br>advantage of purchasing against in-plant production.<br>Power requirement in peak kW demand and annual kWh<br>consumption, initial and future.

Electrical system shown by single line diagram showing<br>major power uses.

Fuel for heat, steam and plant processes.

Water balance of plant where applicable. Problems relat-<br>ive to water treatment, disposal of effluents (liquid and<br>gaseous), including any which may be serious or dangerous.

Transportation facilities for raw materials and finished<br>products.

(c) Materials for use in manufacturing process

Quantity, specifications, source and availability of raw<br>and semi-finished materials.

Proofed reserves in case of mineral materials.

If semi-processed materials are to be obtained from<br>another plant, evaluate the technical and economic sound-<br>ness of such plant.

Estimated costs, possible cost variations, source of<br>any preliminary agreements on prices and deliveries and<br>details of any contracts entered into for supplies and major<br>raw materials.

Available facilities for handling and storing.

(d) Plants and specifications

Preliminary plans for all construction work in sufficient<br>detailed to permit calculations 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.

(c) 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.

(d) Special construction problems foreseen

Climate 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.

(e) 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.

(f) 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.

Plan for recruiting and training.

Provisions for competent management and maintenance throughout the life of the proposed loan.

(g) General technical soundness

Justification of selection of location for project.

Proven 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 forecast of earnings, receipts and expenditures, prepared as per annex E.

Estimated level of production and sales at break-even point.

Estimated 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.
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 amortisation).

6. Net capital assets (3 to 5 inclusive).

7. Intangibles (patents, licences, goodwill, trademarks, formulas, franchise, 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).

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:

<table>
<thead>
<tr>
<th>Ordinary</th>
<th>Preference</th>
<th>Deferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. used</td>
<td>amount</td>
<td>No. issued</td>
</tr>
</tbody>
</table>

   3. Indicate number and type of shares held by any individual 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 rates, renewal arrangements and unused credit limits.


7. Pledging situation 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 acquisition during the year, at cost minus retreatment 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 for 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 written off as of the date of the latest balance sheet and percentage of nominal value at which claims are recorded in the balance sheet.

* Annexes A and B are omitted.
## ANNEX II

### Industrial or commercial project

Forecast of earnings, receipts and expenditures

<table>
<thead>
<tr>
<th></th>
<th>Present operation</th>
<th>Construction phase</th>
<th>Operative phase</th>
</tr>
</thead>
</table>

### 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 x 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)
   - (d) Short-term loans
17. Other receipts (describe)
18. Total receipts (13 to 17 inclusive)

### C. Use of funds

19. Construction expenditure:
   - (a) This AID project
     - Foreign currency
     - Local currency
     - Total AID project
   - (b) Other construction
20. Debt service:
   - (a) Amortization of principal
     - Existing DLF or AID loans
     - AID loan proposed herein
     - Other borrowings
   - (b) Interest
     - Existing DLF or AID loans
     - AID loan proposed herein
     - Other borrowings
21. Other expenditures (describe)

---

### Notes

- Revenue: (separately for each major product or category of sales)
- Operating expenses: (a) Manufacturing
- Taxes (describe)
- Interest on long-term debt (5-9)
- Net profit (or loss) (10-11)
- Borrowings: (a) Existing DLF or AID loans
- Debt service:
  - (a) Amortization of principal
  - (b) Interest
ANNEX E (continued)

D. Cash flow
25. Annual cash surplus (or deficit)  
   (issue 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 (30 to 31 inclusive)  
33. Accumulated depreciation  
34. Not 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 (authorized, 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 6
Industrial project
Production cost
Cost per unit of output (pound, ton, thousand, etc. based on  
   —— units per day or —— units per year)  

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity required</th>
<th>Price</th>
<th>Cost per unit of product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour (classes and</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>rates)</td>
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<td></td>
<td></td>
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<tr>
<td>Raw materials (list)</td>
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<td></td>
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<tr>
<td>Power</td>
<td></td>
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<td>Fuel</td>
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<td>Utilities</td>
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<td></td>
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<tr>
<td>Supplies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisory and technical salaries (classes and rates)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other direct costs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total direct plant cost</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

APPENDIX 6
OUTLINE OF INFORMATION REQUIRED BY IBRD ON  
SHORT 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, evaluation 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 breakdowns) 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?
(a) Construction and installation schedule
(b) Proposed sources of raw materials, labour, power, water, transportation, etc.
(c) Present status of the project
   1. Expenditures to date
   2. Equipment on order
   3. Problems, if any

(d) Market
   1. Information on existing markets and plans for
      supplying and expanding them
      Imports in past years
   2. Estimated demand and production costs as com-
      pared with selling prices of competition, in-
      cluding export duties on raw materials and
      finished goods, transportation costs, etc.
   3. Methods of marketing the product and adequacy
      of the present or planned distribution set-up

3. Estimated unit production for each of the first
   three years of operation
   1. Estimated sales revenues, costs and expenses
      (including interest, depreciation and taxes sepa-
      rately) and net profits for each of the first
      three years of operation. Profits should be
      related to all financial charges, including proba-
      ble dividend payments
   2. Cash flow estimate for each construction year
      through the first year of normal operation (see
      annexes)
   3. Pro forma balance sheets as at the completion
      of the project and first year of normal operation

4. General economic justification of the project (if
   applicable)
   1. Over-all benefits to the country
   2. Utilization of unemployed natural resources
   3. Employment of labour
   4. Foreign exchange savings
   5. Economic diversification
   6. Benefits to other industries

5. Any other relevant information e.g. on necessary
   government licenses, permits, effect of tariffs, taxes,
   etc.

3. Proposed loan
   1. Amount requested
   2. Pre-proposed term loan repayment schedule specifying
      the proposed grace period
   3. Security available for loan
   4. Credit standing of proposed guarantors, if any
   5. Any special legal, tax or corporate considerations

Application of funds

3. Investment in fixed assets:
   1. Other construction
   2. Renewals and replacement
   3. Interest during construction, if capital
      allowed

4. Interest
   1. Short-term debt
   2. Other long-term debt (excluding that which
      is capitalized)

5. Amortization
   1. Other long-term debt

6. Other loans
   1. Other long-term debt
   2. Other

Information to be submitted with this application for
clarification in respect of credits between $1,000 and
$5,000
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

Cash flow

Sources of funds

Net income before taxes and interest

Depreciation

Total cash generated from operations

Sale of capital stock

Increase in long-term debt

Other

Increase in short-term debt

Increase in other current liabilities

Decrease in current assets (other than

Cash)

Other (offset)

Application of funds

Investment in fixed assets:

IBRD

Other construction

Renewals and replacement

Interest during construction, if capital allowed

Interest

Short-term debt

Other long-term debt (excluding that which is capitalized)

Amortization

IBRD

Other long-term debt

Other loans

Other long-term debt

Other

Cash surplus or deficit for year

Cash balance at beginning of year

Cash balance at end of year
XVIII. SURVEY OF LITERATURE ON COST-BENEFIT ANALYSIS FOR INDUSTRIAL PROJECT EVALUATION

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 received 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 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 year eight and so on.

This principle of a variable discount rate is necessary in order to reach proper decision on timing and scale, and is particularly important in reaching valid decisions in years in which uncertain funds are either particularly abundant or particularly scarce relative to existing investment opportunities.

Section B focuses on the measurement of benefits and costs and particularly on how to price the path of expected benefits and costs throughout years. Initially, the basic principles underlining the decisions are reviewed: market rates for: (a) the marginal productivity of capital; (b) the rate of time preference; (c) the real cost of the product of the project. It is concluded that the rate of time preference reflects the fact that it is developing costs that are not expected to rise relative to productive capacity in general so that the excess of the price of the output commodity is the net change in total discounted benefits and costs of a product in a given year over its cost of production. Then Section B discusses the use of marginal productivity in project evaluation. It is suggested that the gap between social costs and market prices may be sought in many cases and that the result be incorporated in the use of accounting prices. The final section of Section A, however, goes on to discuss the proper use of estimating accounting prices.

In the case of labor, the need for employing accounting prices for labor is discussed and it is suggested that a minimum accounting rate of return be employed. It is suggested that a minimum accounting price for urban labor at a given wage is often obtained from the wage rate received by labor of that type employed within the urban complex in activities in which wages are not influenced either by minimum wage legislation or union agreements. It is explicitly concluded that the marginal productivity of labor in agriculture is not a relevant measure of the accounting price of urban labor.

*University of Chicago, United States of America
The method of setting the accounting price of foreign exchange is then outlined, the principle involved being that 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 how 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 charges 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 separate 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 for 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 equation:

\[
\sum_{t=0}^{N} \frac{B_t - C_t}{(1 + r)^t} = 0,
\]

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 adjusts for the depreciation of the project's cost. Thus, if a project has a capital cost of 100 in year 0, and yields a benefit of 150 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 150 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 \( B_t - C_t \) 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, it 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 independently 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 1 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
cases 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 unused facilities to their former state) (see 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 values of benefits is just equal to the present value of costs. But another solution is a 11.11 percent rate, for setting

\[
\frac{1}{1 + \rho} + \frac{1}{(1 + \rho)^2} = 9, \text{ and } \left(\frac{1}{1 + \rho}\right)^2 = 81
\]

we obtain

\[
\frac{-900}{1 + \rho} + \frac{1900}{(1 + \rho)^2} = 1000
\]

\[
\Rightarrow -900 + 1710 - 810 = 0.
\]

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

\[
\text{(Figure 1 a)}
\]

\[
\text{(Figure 1 b)}
\]

\[
\text{(Figure 1 c)}
\]
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 $324,000 per year in perpetuity on a capital investment of $2$ million, while project $A$ has a net benefit of $440,000 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 $400,000, from which deducting the project cost of $320,000 we obtain a net excess of benefits over costs of $80,000. In spite of project $B$'s higher ratio of benefits to costs, project $B$ is preferable because $320,000 is invested in $B$ rather than $2$ million in $A$ in the first alternative use for the $1,600,000 thus saved as 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 in Roland N. McKean, Efficiency in Government through Systems Analysis and in J. Hirshleifer, "On the theory of optimal investment decision." All these writers recognize the disadvantages indicated above.

2. Choice of discount rates for use in connection 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 comparison 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 uneconomical. 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 cannot 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-
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 could, therefore, underestimate 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 based 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 element. 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 cost, the consequence would be an element of monopoly profit 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 F. Stone in Capital and Rates of Return in Manufacturing Industry, and by John W. Kendrick in Productivity Trends in the United States; 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

R. Stone, op. cit., p. 40.
problems of measuring the social as distinct from
the private yield on private sector capital.

There are a number of possible sources of di-
vergence 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 cor-
porate 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
corporation 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
indicted procedure is therefore to include corpo-
rations 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
doing certain possible divergences between market
prices and opportunity costs, see A. C. Harberger.
“Investment in man versus investment in machines:
The case of India.”

(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
governingly substantially underestimate the oppor-
tunity 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 al-
lowance has been made for uncertainties and
risks.”

“Interest rates are a measure of the value at-
tached 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 pro-
jects can be financed at a lower rate than private
industry. The government rate of borrowing is
relatively risk free because the security is the gen-
eral 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 pub-
lic investment costs and that higher rates be used
for private investment costs.”

The approach reflected in both of the above quota-
tions fails to appreciate the difference between
the market interest rate on bonds and the opportuni-
ty 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 capi-
tal, to be derived from the marginal yield of
projects as well as from the marginal rates to be
paid for foreign loans.”

Tinbergen suggests the use of a 10 per cent inter-
est rate, which is far above the rates applying to
government bonds in most countries, and which
undeniably lies closer to the opportunity cost of
capital than the government bond rate.

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1 United States Inter-Agency Committee on Water Re-
sources, Proposed Practices for Economic Analysis of Re-
source Projects, Washington, D.C., Government Print-

2 H. W. Singer, “Development projects as part of national
development programmes”, in Perspectives and Economic
Appraisal of Development Projects, United Nations pub-

3 J. Tinbergen, The Design of Development, Baltimore
Lately, 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 reject 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 $1.00 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 economies". 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 10: 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 "case" 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 $2 per year, where $1 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 $p per year which, discounted back to the present at the social rate of discount, would have a present value of $p/r. If the fraction of public funds is raised at the expense of investment, and the fraction (1 - q) at the expense of consumption, the present value of the foregone alternatives of a dollar of public funds will be $p/[q/r + (1 - q)]. 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 $p/[q/r + (1 - q)]. 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, severe 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..."
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 interest 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.

(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 1 1/2 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.18

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 high 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 investable 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 scarcer, and lower if funds are relatively abundant. This can be done by attaching to each year a discount rate that corresponds to the expected rate of investment 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 r1 to bring them back to the present. Likewise, we would discount benefits and costs accruing two years hence by the rate r2 to bring them back to one year from now, and then by the rate r3 to bring them back to the present. Thus, the acceptance or rejection of a three-year project would turn on whether the sum

\[ \frac{(B_3 - C_3)}{(1 + r_3)} + \frac{(B_2 - C_2)}{(1 + r_2)} + \frac{(B_1 - C_1)}{(1 + r_1)} + \frac{R}{(1 + r_1)(1 + r_2)(1 + r_3)} \]

was greater or less than zero. The general form of this criterion, for a project of N years duration, is

\[ \frac{R}{(1 + r_1)(1 + r_2) \cdots (1 + r_N)} \]

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 rate 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 desired rate of interest. The optimum policy may well involve negative bond financing, i.e., government lending or retirement of the national debt."

19 Stigler, op cit. (see footnote 4 above), p. 283.
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. 26

II. 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. The techniques of projection appropriate to any given case can only be 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 overall 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. If the projected level of income is not directly tied to the level of capital accumulation in the community, but is the resultant of many factors, of which capital accumulation is only one. 27

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 rate 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 28 Care must be taken, however, to allow for possible future changes in the quality 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. 29 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 the analysis should include projections of the probable paths 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-wiliness 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 $P_t/P_0$, where $P_t$ is the price of the project's output, and $P_0$ is 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, $P_0$, in order to express future years' prices.


29 See for example, "Projection of Demand for Industrial Equipment", in Industrialization and Its Discontents, Institute No. 7, United Nations publication, Sales No. 64-I, B-1.
prices in monetary units of the initial year's purchasing power. Thus the projected price series would be of the form \( P_{t+1} = (P_t/P_0)(P_0/P_{t-1}) \).

The factor \((P_t/P_0)(P_0/P_{t-1})\), will average out to unity over the whole economy when the appropriate weighted average is taken for

\[
\sum_i \left( \frac{Q_{it}P_{it}}{\bar{P}_{it}} \right) \frac{P_{it}}{P_{it}} = \frac{\sum_i Q_{it}P_{it}}{\sum_i Q_{it}P_{it}} = \frac{P_{it}}{P_{it}} = 1.
\]

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 issues is to be found in the ECMA Manual, pp. 26-29.

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
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 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 \[ \Sigma (MSB_i - MSC_i) \Delta Q_i \], where the subscript i varies over all industries for which \( MSB_i > MSC_i \).

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..."

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..."

"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 market 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 underestimate the amount of resources used in their production. In these cases, accounting prices should be calculated also..."

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..."
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 valuation 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. 1, 2, 3

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 equal wage rates in rural employment. The "shadow wage" for urban employment 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, 3 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 rate of 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 wage rate below its opportunity cost. These latter forces include, wage rates 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 possible 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

1 See from page 22 above

2 "Evaluation of projects in predominantly private enterprise economies", Bulletin on Industrialization and Productivity, No. 5, United Nations publication, Sales No. E/21141, p. 20

3 See from page 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 true 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 material-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 neighborhood of $5, say, between $4.80 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
m 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 $3 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." 22

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'."

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

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22 Op cit (see footnote 26 above), p 30.
23 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 $.10, 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 $.10, but other consumers would lose $.10 per unit, so that the total social benefit would be $.10 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. 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 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 it is a consequence of this that 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 uncertainties as to the validity of the resulting “shadow prices.”

1. Problems of taxation

As the analysis of section 4 showed, the problem of placing projects with different time patterns 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, \ldots, \( N \) 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 $1,100 per year in perpetuity in order to be justified at a 10 per cent discount rate, starting a year from now. But a project whose construction costs were spread out over five years, in equal amounts 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 increase 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 $550 per year in perpetuity in order to make the investment worthwhile 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

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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."235

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), evaluated as of this year. Obviously, it pays to postpone construction of the project, so long as r, 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 in 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 because the net benefit accruing in any future year will vary, depending, on the date of construction ($i$ is a function of 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 chooses $i$ 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 equated to its cost of construction times the interest rate $r_i$.

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 $r_i$. 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 such that 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 $r_i$ 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* 27.

29 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. 42-44.
27 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, generally 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." 28

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" and Hirschleifer comes to a similar conclusion. 29 Arrow, however, argues 30 that the government should display risk aversion, that is, should not incorporate a risk premium in the discount rate it uses, and Marglin maintains 31 that where the net-benefit stream is rising over time, the criteria arrived at in section I, 32 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 at those 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, explicitly 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, are such likely to be very different for different types and lines of investment, the adjustment for these changes should be carried out by as detailed a 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, and the wide variety of governmental investments creates a substantial amount of risk reduction through diversification. Moreover, the private sector investment 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, 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 component 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 the 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 justifiable, each in the programme, and each separable segment of a project should add as much or more benefits as it adds costs." 33

This principle is indeed the correct one to apply so long as all projects having a positive net benefit over costs can be treated, a proviso that we have assumed to be met given the possibility of government borrowing. However, it is important...
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 \( PVR(A) \) 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, \( PVBR(B) \) represents the present value of the benefits of project \( B \), undertaken alone, and \( PVR(AB) \) 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 \( PVR(AB) > PVB(A) + PVB(B) \);

(b) Substitutes on the benefit side when \( PVR(AB) < PVB(A) + PVB(B) \);

(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 \( N = PVR - PVC \) 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, \( B \) 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: \( A_1, A_2, A_3, B_1, B_2, B_3, A_1B_1, A_2B_2, A_3B_3, A_1B_2, A_2B_3, A_3B_2, A_1B_3, A_2B_2, A_3B_3, \) 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 análisis de los costos y beneficios sociales en la industria azucarera nacional: S.A.", in Estudios de Economía, Santiago, Catholic University of Chile, 1961, pp. 31-32.
XIX. FOLLOW-UP PROCEDURES AND PRACTICES

by H. T. Parikh*

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.

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 exists 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.

Advances 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 proceeds for 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 on time and building materials do not flow in as estimated. Delivery schedules of equipment become prolonged.

Many ICICI-financed projects have confronted delays for various reasons. Of the 229 projects financed by ICICI, delays have been determined in 202 cases, as shown in the following table.

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project completion delays</td>
<td>134</td>
</tr>
<tr>
<td>Economic conditions</td>
<td>10</td>
</tr>
<tr>
<td>Government permission</td>
<td>4</td>
</tr>
<tr>
<td>Difficulties of execution</td>
<td>13</td>
</tr>
</tbody>
</table>

*General Manager, Industrial Credit and Investment Corporation of India (ICICI), Bombay
Table 1: Delays

<table>
<thead>
<tr>
<th>Number of projects</th>
<th>Completed projects under construction</th>
<th>Percentage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No delay</td>
<td>24</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>Less than 6 months</td>
<td>19</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>Between 6 and 12</td>
<td>16</td>
<td>21</td>
<td>47</td>
</tr>
<tr>
<td>12 months</td>
<td>15</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Between 18 and 24</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>24 months and above</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Not known</td>
<td>2</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>96</td>
<td>288</td>
</tr>
</tbody>
</table>

Under the category "not known" are included projects with planned 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.

Overruns 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 146 projects, as shown in the following table.

Table 2: Overruns

<table>
<thead>
<tr>
<th>Category of overrun</th>
<th>Number of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>No overrun</td>
<td>68</td>
</tr>
<tr>
<td>Less than 10 per cent</td>
<td>19</td>
</tr>
<tr>
<td>Between 10 and 30 per cent</td>
<td>23</td>
</tr>
<tr>
<td>Between 30 and 40 per cent</td>
<td>27</td>
</tr>
<tr>
<td>40 per cent and above</td>
<td>13</td>
</tr>
<tr>
<td>Not known</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
</tr>
</tbody>
</table>

Note: The eighty projects included under the category "not known" consist of projects either still in the plan stage or in a preliminary stage of construction and also the revised cost estimates have not been fixed 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 assisted 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 portion 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 prematurely 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 product having 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.

Work 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 technical 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 sources 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 the 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 overall 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 (q). 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 feedback 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 institution 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 skillfully, 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
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

<table>
<thead>
<tr>
<th>Causes of failure (in percentages)</th>
<th>Canada</th>
<th>United States of America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of failures</td>
<td>2,002</td>
<td>13,501</td>
</tr>
<tr>
<td>Causes of failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neglect</td>
<td>1.5</td>
<td>28</td>
</tr>
<tr>
<td>Fraud</td>
<td>0.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Lack of experience in the line</td>
<td>5.2</td>
<td>8.8</td>
</tr>
<tr>
<td>Lack of managerial experience</td>
<td>23.2</td>
<td>20.9</td>
</tr>
<tr>
<td>Unbalanced experience</td>
<td>13.2</td>
<td>19.7</td>
</tr>
<tr>
<td>Incompetence</td>
<td>55.3</td>
<td>42.5</td>
</tr>
<tr>
<td>Disaster</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Reason unknown</td>
<td>0.2</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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 judgment.

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 connection 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 would 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 utmost 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

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funds are needed for an expansion, or to tide the
business over a period of difficulty, the basic re-
relationship should be such that the financing institu-
tion 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 con-
tributing factor to the growth of management ex-
pertise in developing countries. A frequent charac-
teristic 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 gen-

eral
erally have a shrewd idea of any shortcomings, al-
though 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 in-
stitutes a system by which each of his senior man-
agers 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 cor-
related; he will learn of shortcomings a long time
after they should have become apparent. By re-
quiring follow-up information, the financing institu-
tion provides an extra incentive for the installation
of a system for producing complete management in-
formation quickly and accurately.

The final side-effect is the information it provides
and the lessons it teaches for use in future ap-
praisals. It will throw light both on the efficacy of
the management’s estimating and forecasting pro-
cedures 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
particular aspects of project preparation. For in-
stance, systematic analysis of follow-up reports will
give early warning to the staff of a financing institu-
tion that, in a certain country, capital estimates are
regularly understated because management 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 super-
visors 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 obtain-
able 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 financ-
ing 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 repre-
sentatives 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, its
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 profes-
sional 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 en-
gineering 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 man-
gement 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 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—who do not play so large a part 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 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—he 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 encounters 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 requires 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."

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 sep-


arated 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: (table follows)
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 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 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 management 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; defects in 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 of 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 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 quarter 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.

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:

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital employed</th>
<th>Net sales</th>
<th>Net profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>100,000</td>
<td>60,000</td>
<td>10,000</td>
</tr>
<tr>
<td>1961</td>
<td>100,000</td>
<td>60,000</td>
<td>10,000</td>
</tr>
<tr>
<td>1962</td>
<td>100,000</td>
<td>75,000</td>
<td>13,000</td>
</tr>
<tr>
<td>1963</td>
<td>120,000</td>
<td>80,000</td>
<td>14,000</td>
</tr>
<tr>
<td>1964</td>
<td>150,000</td>
<td>120,000</td>
<td>16,000</td>
</tr>
</tbody>
</table>

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 ratio, 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, 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

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

SPECIMEN ANALYTICAL TABLE FOR USE BY THE FINANCING INSTITUTION'S FOLLOW-UP STAFF

Analysis of operating progress report: Quarter ending 19...

<table>
<thead>
<tr>
<th>Original forecast for the year***</th>
<th>Quarterly figures</th>
<th>Cumulative figures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Previous quarter***</td>
<td>Budgeted***</td>
</tr>
<tr>
<td>Total net capital employed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production in units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production as percentage of capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales: Units*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit before interest and tax</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit before tax</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net profit before interest and tax as percentage of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Net capital employed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stocks other than finished goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finished stocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total stocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade debtors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade creditors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank overdraft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net current assets liabilities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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 Baez 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 coke production sources, and relatively near to hydroelectric power in one case, and to non-coke 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; second, calculating the prices of those inputs vary between minimum and maximum possible values, and thirdly, finding out the impact of those 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 not only to Mexico, and the plus sign means a product or by-product. All the inputs are given as a unit of the product.

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 advantages 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.

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. The minus sign means an input, and the plus sign means a product or by-product. All the inputs are given as a 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 equations formulated with the data given.

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.


3 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.

4 The equations relating investment and labour with productive capacity are the following:

$$\frac{I_2}{I_1} = \left(\frac{C_2}{C_1}\right)^a$$

$$\frac{L_2}{L_1} = \left(\frac{C_2}{C_1}\right)^b$$

$I_1$, $L_1$, $I_2$, $L_2$ represent the investment and labour requirements which correspond to productive capacity levels of $C_1$ and $C_2$, respectively; $a$ and $b$ are exponents which express the variations 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.

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.

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.

The factors used in this work are the following:

<table>
<thead>
<tr>
<th>Labor cost factor</th>
<th>Capital cost factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision</td>
<td>0.200</td>
</tr>
<tr>
<td>Maintenance</td>
<td>0.100</td>
</tr>
<tr>
<td>Social security and welfare</td>
<td>0.200</td>
</tr>
<tr>
<td>Administrative cost</td>
<td>0.150</td>
</tr>
<tr>
<td>Depreciation</td>
<td>0.050</td>
</tr>
<tr>
<td>Insurance</td>
<td>0.010</td>
</tr>
<tr>
<td>Opportunity cost of capital</td>
<td>0.080</td>
</tr>
<tr>
<td>Others</td>
<td>0.550</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>1.200</strong></td>
</tr>
</tbody>
</table>

These factors are related in the following equation, expressed in any monetary unit:

\[
C_i = \frac{1.20 C_t + 0.19 I}{T}
\]

in which \(C_i\) is the indirect unit cost; \(C_t\) 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 $0.90 per man-hour.

The refractory expense was estimated as follows, in dollars per ton of pig iron, or steel:

<table>
<thead>
<tr>
<th>Reduction</th>
<th>Steel-making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast furnace</td>
<td>0.75</td>
</tr>
<tr>
<td>Electric furnace</td>
<td>0.80</td>
</tr>
<tr>
<td>Electric furnace with pre-reduction</td>
<td>0.80</td>
</tr>
<tr>
<td>Open hearth</td>
<td>4.48</td>
</tr>
<tr>
<td>Converter</td>
<td>0.84</td>
</tr>
<tr>
<td>With scrap</td>
<td>1.12</td>
</tr>
<tr>
<td>With sponge iron</td>
<td>1.28</td>
</tr>
<tr>
<td>With pig iron</td>
<td>1.68</td>
</tr>
</tbody>
</table>

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, much 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 physical tables, and the inclusion of monetary input, which are not expressed in the coefficient matrices, the input-output tables are transformed into physical into monetary units; the purpose is to interrelate tables belonging to different industries, as well as to interrelate an industry with other sectors, by means of the current 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 minimize 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 shadow costs, differences are important in both relative and absolute terms.
ANNEX I

ACTUAL FREIGHT RATES AND SHIPYARD 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

<table>
<thead>
<tr>
<th>Activity number</th>
<th>Activity description</th>
<th>Activity number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Sinter processes</td>
<td>3.8</td>
</tr>
<tr>
<td>1.2</td>
<td>Washed coal and natural gas</td>
<td>3.9</td>
</tr>
<tr>
<td>1.3</td>
<td>Small scale plants</td>
<td>(b) Electric furnace</td>
</tr>
<tr>
<td>1.4</td>
<td>Coke breeze and fuel oil</td>
<td>3.10</td>
</tr>
<tr>
<td>1.5</td>
<td>Coke breeze and natural gas</td>
<td>3.11</td>
</tr>
<tr>
<td>1.6</td>
<td>Iron ore fines, coke breeze and fuel oil</td>
<td>3.12</td>
</tr>
<tr>
<td>2.1</td>
<td>Coke</td>
<td>3.13</td>
</tr>
<tr>
<td>2.2</td>
<td>Normal coke production vector</td>
<td>3.14</td>
</tr>
<tr>
<td>2.3</td>
<td>Pig iron</td>
<td>3.15</td>
</tr>
<tr>
<td>(a) Blast furnace</td>
<td>3.16</td>
<td>(c) Electric furnace with pre-reduction</td>
</tr>
<tr>
<td>3.1</td>
<td>100% sinter; natural gas acting as fuel and as reducing agent</td>
<td>3.17</td>
</tr>
<tr>
<td>3.2</td>
<td>100% sinter; fuel oil</td>
<td>3.18</td>
</tr>
<tr>
<td>3.3</td>
<td>100% sinter; without using hydrocarbons</td>
<td>3.19</td>
</tr>
<tr>
<td>3.4</td>
<td>50% sinter and 50% iron ore; natural gas</td>
<td>3.20</td>
</tr>
<tr>
<td>3.5</td>
<td>50% sinter and 50% iron ore; fuel oil</td>
<td>4.1</td>
</tr>
<tr>
<td>3.6</td>
<td>50% sinter and 50% iron ore; without hydrocarbons</td>
<td>(a) Open hearth ('Sermacs Marnia') furnace</td>
</tr>
<tr>
<td>3.7</td>
<td>100% iron ore; natural gas</td>
<td>4.2</td>
</tr>
</tbody>
</table>
### Table 1. List of the sixty-seven steel mill activities included in this study (continued)

<table>
<thead>
<tr>
<th>Activity number</th>
<th>Activity description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>65% pig-iron and 35% scrap; oxygen</td>
</tr>
<tr>
<td>4.3</td>
<td>60% pig-iron and 40% scrap; oxygen</td>
</tr>
<tr>
<td>(b) Converters</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Lime-Dolomites (1:1)</td>
</tr>
<tr>
<td>4.5</td>
<td>Kaldò</td>
</tr>
<tr>
<td>(c) Electric furnace</td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>Sponge iron and iron ore</td>
</tr>
<tr>
<td>4.7</td>
<td>Sponge iron; oxygen</td>
</tr>
<tr>
<td>4.8</td>
<td>Scrap and iron ore</td>
</tr>
<tr>
<td>4.9</td>
<td>Scrap; oxygen</td>
</tr>
<tr>
<td>4.10</td>
<td>Pig-iron and scrap; oxygen</td>
</tr>
<tr>
<td>5.1</td>
<td>Moulds (normal vector)</td>
</tr>
<tr>
<td>5.2</td>
<td>Other products (average inputs)</td>
</tr>
<tr>
<td>5.3</td>
<td>Steel castings (average inputs)</td>
</tr>
<tr>
<td>6.1</td>
<td>Slabs</td>
</tr>
<tr>
<td>6.2</td>
<td>Rolling mill</td>
</tr>
<tr>
<td>6.3</td>
<td>Strip; Stencil, or reversing mill</td>
</tr>
<tr>
<td>6.4</td>
<td>Strip; semi-continuous mill</td>
</tr>
<tr>
<td>6.5</td>
<td>Strip; continuous mill</td>
</tr>
<tr>
<td>6.6</td>
<td>Sheets over 3 mm thickness</td>
</tr>
<tr>
<td>6.7</td>
<td>Sheets under 3 mm thickness</td>
</tr>
<tr>
<td>(c) Cold rolled products</td>
<td></td>
</tr>
<tr>
<td>6.8</td>
<td>Strip; semi-continuous mill</td>
</tr>
<tr>
<td>6.9</td>
<td>Strip; continuous mill</td>
</tr>
</tbody>
</table>

### Table 2. Physical input-output coefficients for the production of sinter and coke

(Metric tons)

<table>
<thead>
<tr>
<th>Input</th>
<th>Sinter</th>
<th>Coke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear exogenous inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron ore (60% Fe)</td>
<td>-0.936</td>
<td>-0.936</td>
</tr>
<tr>
<td>Washed coal</td>
<td>-0.075</td>
<td>-0.075</td>
</tr>
<tr>
<td>Electric energy (100 kWh)</td>
<td>-0.005</td>
<td>-0.005</td>
</tr>
<tr>
<td>Natural gas (100 m³ = 0.9 × 10⁶ KCal)</td>
<td>-0.110</td>
<td>-0.110</td>
</tr>
<tr>
<td>Lime stone</td>
<td>-0.050</td>
<td>-0.050</td>
</tr>
<tr>
<td>Mineral fines</td>
<td></td>
<td>-0.936</td>
</tr>
<tr>
<td>Linear endogenous inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coke fines</td>
<td>-0.055</td>
<td>-0.055</td>
</tr>
<tr>
<td>Products and byproducts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinter</td>
<td>+1.000</td>
<td>+1.000</td>
</tr>
<tr>
<td>Coke</td>
<td></td>
<td>+1.000</td>
</tr>
<tr>
<td>Coke gas (1000 m³ N)</td>
<td></td>
<td>+0.200</td>
</tr>
<tr>
<td>Coke fines</td>
<td></td>
<td>+0.100</td>
</tr>
</tbody>
</table>

Non-linear exogenous inputs

<table>
<thead>
<tr>
<th>Activity</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual capacity (10⁶ t/year)</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Investment (10⁸ dollars)</td>
<td>5700</td>
<td>5700</td>
<td>5700</td>
<td>5700</td>
<td>5700</td>
<td>5700</td>
</tr>
<tr>
<td>Exponent investment equation</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
<td>0.600</td>
</tr>
<tr>
<td>Labour (10⁶ t)</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Exponent labour equation</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
</tr>
</tbody>
</table>

Capacity limits considered:

| Lower (10⁶ t) | 3500 | 3500 | 3500 | 3500 | 3500 | 3500 |
| Higher (10⁶ t) | 2500 | 2500 | 2500 | 2500 | 2500 | 2500 |

Source: Industrial Programming Division, National Financiera, S.A. (Mexico)
Table I follows.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Pig-iron production in blast furnaces</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td></td>
</tr>
<tr>
<td>Linear exogenous inputs</td>
<td></td>
</tr>
<tr>
<td>Iron ore (Fe 60%)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Pellets</td>
<td></td>
</tr>
<tr>
<td>Washed coal</td>
<td></td>
</tr>
<tr>
<td>Anthracite</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>-0.20</td>
</tr>
<tr>
<td>Quick lime</td>
<td></td>
</tr>
<tr>
<td>Manganese ore (35%)</td>
<td>-0.04</td>
</tr>
<tr>
<td>Fluorspar</td>
<td></td>
</tr>
<tr>
<td>Graphite</td>
<td></td>
</tr>
<tr>
<td>Soderberg electrodes</td>
<td></td>
</tr>
<tr>
<td>Natural gas (100 m^3 N = 0.9 \times 10^8 KCal)</td>
<td>-1.00</td>
</tr>
<tr>
<td>Steam</td>
<td>-1.80</td>
</tr>
<tr>
<td>Electric energy (100 kWh)</td>
<td>-0.35</td>
</tr>
<tr>
<td>Water 100 m^3</td>
<td>-0.15</td>
</tr>
<tr>
<td>Fuel oil (100 lt = 10^8 KCal)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Linear endogenous inputs</td>
<td></td>
</tr>
<tr>
<td>Sinter (Fe 50%)</td>
<td>-1.71</td>
</tr>
<tr>
<td>Coke (80% ash)</td>
<td>-0.80</td>
</tr>
<tr>
<td>Coke breeze (30% ash)</td>
<td></td>
</tr>
<tr>
<td>Products and byproducts</td>
<td></td>
</tr>
<tr>
<td>Pig-iron</td>
<td>+1.00</td>
</tr>
<tr>
<td>Sponge iron</td>
<td>+2.62</td>
</tr>
<tr>
<td>Blast furnace gas (10^8 m^3 N)</td>
<td>+0.39</td>
</tr>
<tr>
<td>Electric furnace gas (1,000 m^3 N)</td>
<td></td>
</tr>
<tr>
<td>Slag</td>
<td></td>
</tr>
<tr>
<td>Non-linear exogenous inputs</td>
<td></td>
</tr>
<tr>
<td>Capacity (10^6 t/ year)</td>
<td>1,000</td>
</tr>
<tr>
<td>Investment (10^6 dollars)</td>
<td>40,000</td>
</tr>
<tr>
<td>Exponent investment equation</td>
<td>0.640</td>
</tr>
<tr>
<td>Labor (m-h/t)</td>
<td>0.760</td>
</tr>
<tr>
<td>Exponent labor equation</td>
<td>0.500</td>
</tr>
<tr>
<td>Capacity limits considered:</td>
<td></td>
</tr>
<tr>
<td>Lower (10^6 t/ year)</td>
<td>0.400</td>
</tr>
<tr>
<td>Higher (10^6 t/ year)</td>
<td>1.500</td>
</tr>
</tbody>
</table>

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).
### FOR THE PRODUCTION OF PRIMARY IRON (tons)

<table>
<thead>
<tr>
<th>Electric reduction furnace</th>
<th>Electric furnace with pre-reduction</th>
<th>Sponge iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.600</td>
<td>1.600</td>
<td>0.800</td>
</tr>
<tr>
<td>-0.625</td>
<td>-0.625</td>
<td>-0.425</td>
</tr>
<tr>
<td>-0.400</td>
<td>-0.400</td>
<td>-0.130</td>
</tr>
<tr>
<td>-0.045</td>
<td>-0.045</td>
<td>-0.045</td>
</tr>
</tbody>
</table>

-1.000 | -1.000 | -0.800 | -0.800 | -0.800 | -0.800 | -0.800 | -0.800 |
| -0.600 | -0.600 | -0.400 | -0.400 | -0.400 | -0.400 | -0.400 | -0.400 |

-1.710 | -1.710 | -0.885 | -0.885 | -0.885 | -0.885 | -0.885 | -0.885 |

+1.000 | +1.000 | +1.000 | +1.000 | +1.000 | +1.000 | +1.000 | +1.000 |


+0.631 | +0.631 | +0.631 | +0.631 | +0.631 | +0.631 | +0.631 | +0.631 |

| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 49.000 | 49.000 | 49.000 | 49.000 | 49.000 | 49.000 | 49.000 | 49.000 |

| 0.640 | 0.640 | 0.640 | 0.640 | 0.640 | 0.640 | 0.640 | 0.640 |

| 0.760 | 0.760 | 0.760 | 0.760 | 0.760 | 0.760 | 0.760 | 0.760 |

| 0.900 | 0.900 | 0.900 | 0.900 | 0.900 | 0.900 | 0.900 | 0.900 |

| 0.500 | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 |

| 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 |

| 1.600 | 1.600 | 1.600 | 1.600 | 1.600 | 1.600 | 1.600 | 1.600 |

| 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 |

| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Source       | 0.100/0.016 | 0.6/0.012 | 0.8/0.010 | 0.4/0.014 | 0.7/0.011 | 0.5/0.013 | 0.9/0.015 | 0.3/0.017 | 0.6/0.014 | 0.8/0.012 | 0.4/0.014 | 0.7/0.011 | 0.5/0.013 | 0.9/0.015 | 0.3/0.017 | 0.6/0.014 | 0.8/0.012 | 0.4/0.014 | 0.7/0.011 | 0.5/0.013 | 0.9/0.015 | 0.3/0.017 |
|-------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Steel scrap | 1.0         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Iron ore    | 0.8         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Coke        | 0.6         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Fuel oil   | 0.4         |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| Electric furnaces |        |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |
| |            |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |           |

Note: Industrial Production Division, National Planning, S.A. (Medellin). Values in kilowatt hours.
### Table 5. Physical input-output coefficients for the production of flat rolled products

(Metric tons)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Slabs</th>
<th>Hot rolled strip coils</th>
<th>Hot rolled sheets</th>
<th>Cold rolled strip coils</th>
<th>Cold rolled sheets</th>
<th>Templating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blowing</td>
<td>Continuous casting</td>
<td>Reversing</td>
<td>Semi-continuous casting</td>
<td>Continuous casting</td>
<td>More than 1.6 mm</td>
</tr>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear exogenous inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balls (kg)</td>
<td>-2.000</td>
<td>-2.000</td>
<td>-3.000</td>
<td>-2.000</td>
<td></td>
<td>-2.700</td>
</tr>
<tr>
<td>Tin</td>
<td>-3.100</td>
<td>-0.510</td>
<td>-0.013</td>
<td>-0.095</td>
<td>-0.045</td>
<td>-0.045</td>
</tr>
<tr>
<td>Water (100 m³)</td>
<td>-0.210</td>
<td>-0.100</td>
<td>-0.060</td>
<td>-0.000</td>
<td>-0.060</td>
<td>-0.060</td>
</tr>
<tr>
<td>Steam</td>
<td>-1.700</td>
<td>-0.266</td>
<td>-0.960</td>
<td>-0.650</td>
<td>-0.960</td>
<td>-0.650</td>
</tr>
<tr>
<td>Electric energy (100 kWh)</td>
<td>-0.220</td>
<td>-0.100</td>
<td>-0.060</td>
<td>-0.000</td>
<td>-0.060</td>
<td>-0.060</td>
</tr>
<tr>
<td>Fuel oil (100 lb = 10⁶ KCal)</td>
<td>-0.210</td>
<td>-0.100</td>
<td>-0.060</td>
<td>-0.000</td>
<td>-0.060</td>
<td>-0.060</td>
</tr>
<tr>
<td>Copper (kg)</td>
<td>-0.200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear endogenous inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel ingots</td>
<td>-1.111</td>
<td>-1.053</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Products and by-products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slabs</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plates or hot rolled strip coils</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot rolled sheets of more than 3 mm</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot rolled sheets of less than 3 mm</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold rolled strip coils</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold rolled sheets</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Templatel</td>
<td>+1.000</td>
<td>+1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return scrap</td>
<td>+0.022</td>
<td>+0.050</td>
<td>+0.156</td>
<td>+0.089</td>
<td>+0.109</td>
<td>+0.028</td>
</tr>
<tr>
<td>Mill scale</td>
<td>+0.003</td>
<td>+0.024</td>
<td>+0.034</td>
<td>+0.024</td>
<td>+0.024</td>
<td>+0.024</td>
</tr>
<tr>
<td>Non recoverable waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear exogenous inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual capacity (10⁶ t/year)</td>
<td>1.000</td>
<td>1.000</td>
<td>0.290</td>
<td>0.660</td>
<td>2.000</td>
<td>0.800</td>
</tr>
<tr>
<td>Investment (10⁶ dollars)</td>
<td>22.700</td>
<td>16.500</td>
<td>32.000</td>
<td>40.600</td>
<td>98.000</td>
<td>2.000</td>
</tr>
<tr>
<td>Expenditure investment equation</td>
<td>0.530</td>
<td>0.530</td>
<td>0.530</td>
<td>0.530</td>
<td>0.600</td>
<td>0.600</td>
</tr>
<tr>
<td>Labour (m. h. man)</td>
<td>0.140</td>
<td>0.110</td>
<td>0.120</td>
<td>0.100</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>Expenditure labour equation</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
</tr>
<tr>
<td>Capacity limits considered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower (10⁶ t/year)</td>
<td>0.500</td>
<td>0.500</td>
<td>0.100</td>
<td>0.400</td>
<td>0.700</td>
<td>0.200</td>
</tr>
<tr>
<td>Higher (10⁶ t/year)</td>
<td>2.000</td>
<td>2.000</td>
<td>0.350</td>
<td>0.800</td>
<td>2.000</td>
<td>1.500</td>
</tr>
</tbody>
</table>

Source: Industrial Programming Division, Nacional Financiera S.A. (Mexico).

* Liquid steel.

** The average for the three processes. It cannot be used for calculating the scale factor of any one of them.
<table>
<thead>
<tr>
<th>A-listener</th>
<th>Beams</th>
<th>Bullets</th>
<th>Heavy sections</th>
<th>Rails</th>
<th>Medium sections</th>
<th>Light sections</th>
<th>Wire</th>
<th>Seamless pipes</th>
<th>Piping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear exogenous inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolls (kg)</td>
<td>0.390</td>
<td>-1.200</td>
<td>-1.000</td>
<td>-2.500</td>
<td>-1.500</td>
<td>-2.500</td>
<td>-1.500</td>
<td>-3.000</td>
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Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).
* The same rolling mill may be used for heavy sections and rails.
* The same rolling mill may be used for medium and light sections.
* A separate rolling mill for wire.
<table>
<thead>
<tr>
<th>Input</th>
<th>(Metric tons)</th>
<th>Steel vector</th>
<th>Metal vector</th>
<th>Coke oven</th>
<th>Coke vector</th>
<th>Total inputs per ton of steel</th>
<th>Tons of steel</th>
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<td>Iron ore (Fe 60%)</td>
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<td>Oxygen (100 m³ N)</td>
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<td>Graphite electrodes</td>
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<td>Fuel oil (100 lb = 10³ KCal)</td>
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<td>Ingots moulds</td>
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<td>Natural gas (100 m³ N = 0.9 x 10³ KCal)</td>
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<td>-0.818</td>
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<td>Sinter (Fe 50%)</td>
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<td>Coke (35% ash)</td>
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<td>Coke breeze (30% ash)</td>
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*Sinter in the following activity vectors are considered: steelmaking = EL, reduction = blast furnace using steel and natural gas.
Table 8. Physical input-output matrix

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<th>Cast iron</th>
<th>Steel</th>
<th>Total</th>
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<tr>
<td></td>
<td>Pig iron</td>
<td>Sponge iron</td>
<td>Open hearth furnace</td>
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<td>Iron ore</td>
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<tr>
<td>Coke</td>
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<tr>
<td>Limestone</td>
<td>45,200</td>
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<td>Lime</td>
<td>43,800</td>
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<td>Manganese ore</td>
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<td>Ferroalloys</td>
<td>13,800</td>
<td>11,200</td>
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<td>Fluxes</td>
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<td>Graphite electrodes</td>
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<td>Soderberg electrodes</td>
<td>6,700</td>
<td>(161,2)</td>
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<tr>
<td>Fuel oil (10kgs)</td>
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<tr>
<td>Natural gas (10kgs N)</td>
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<td>Electric energy (10kWh)</td>
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<td>Ingot moulds</td>
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<td>Total endogenous material</td>
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<td>Rails</td>
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<td>Seamless pipes</td>
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<td>Total finished products</td>
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<td>1,370,228</td>
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</table>

* The total supply of pig-iron and scrap is slightly different from their own as inputs in steel-making. This is because their supply
  * The production figures of rolled products expressed as outputs have been adjusted so that they agree with the availability of steel
  * 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

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<td>Products</td>
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<td>Crude iron                                              Pig-iron for steel making Pig-iron for foundries Sponge iron Electric furnace Other types Input moulds Total</td>
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<td>Linear exogenous inputs</td>
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<td>Iron ore</td>
<td>4,402.6                                                    357.0                                                        1,335.0                                                     9.3                                                        40.6                                                        6,243.1</td>
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<td>1,014.9                                                    112.4</td>
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<td>Rolls (100 lbg)</td>
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<td>Manganese ore</td>
<td>126.3                                                      10.1</td>
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<td>Total exogenous material</td>
<td>7,009.1                                                    560.2                                                        1,335.0                                                     650.5                                                      694.2                                                      10,266.1</td>
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<td>Linear endogenous inputs</td>
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<td>Sponge iron</td>
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<td>Electric furnace steel</td>
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<td>Other types of steel</td>
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<td>1,204.7                                                    3,727.5                                                      125.0                                                      1,172.8                                                   9,147.3</td>
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<td>Rolled sections, bars and wire</td>
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<td>Grey iron castings</td>
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<td>Total finished products</td>
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<td>Total inputs</td>
<td>7,009.1                                                    560.2                                                        1,335.0                                                     1,988.2                                                    4,407.9                                                    212.1                                                      15,513.3</td>
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<td>- Wastes and others</td>
<td>4,291.3                                                    387.1                                                        440.0                                                      279.0                                                      313.2                                                      19.7                                                      5,057.0</td>
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<td>= National production</td>
<td>2,707.9                                                    223.1                                                        890.0                                                      1,529.0                                                    3,771.3                                                    122.5                                                      9,456.3</td>
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<td>= Imports</td>
<td>2,097.9                                                    223.1                                                        890.0                                                      1,529.0                                                    3,771.3                                                    122.5                                                      9,456.3</td>
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<tr>
<td>= Total supply</td>
<td>2,097.9                                                    223.1                                                        890.0                                                      1,529.0                                                    3,771.3                                                    122.5                                                      9,456.3</td>
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</tr>
<tr>
<td>= Exports</td>
<td>2,097.9                                                    223.1                                                        890.0                                                      1,529.0                                                    3,771.3                                                    122.5                                                      9,456.3</td>
<td></td>
</tr>
<tr>
<td>= Apparent consumption</td>
<td>2,097.9                                                    223.1                                                        890.0                                                      1,529.0                                                    3,771.3                                                    122.5                                                      9,456.3</td>
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</tr>
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</table>

Source: Industrial Programming Division, National Financeira, S.A. (Mexico).
### Finished products

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<th>Steel castings</th>
<th>Plated products</th>
<th>Structural shapes and bars</th>
<th>Rails</th>
<th>Seamless pipes</th>
<th>Total</th>
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<tr>
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<td>(906.0)</td>
<td>(750.9)</td>
<td>(79.8)</td>
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<td>(906.3)</td>
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<td>(730.3)</td>
<td>(139.9)</td>
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<td>(1,406.0)</td>
<td>(1,248.0)</td>
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<td>(3.7)</td>
<td>(30.3)</td>
<td>(5.5)</td>
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<td>(81.9)</td>
<td>(644.3)</td>
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<th>Mining and metal</th>
<th>Total</th>
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<td>221.6</td>
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<td>2,345.3</td>
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<td>2,345.3</td>
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### Steel bloom

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<th>Size (mm)</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
<th>Length (m)</th>
<th>Density (kg/m³)</th>
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<td>40.0</td>
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<td>2,400</td>
<td>7,592.4</td>
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<td>22.0</td>
<td>1.80</td>
<td>2,800</td>
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**Footnote:**

Casings, etc.
### Table 10: Production cost indexes of steel groups with virtual and shadow prices, for different locations

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<th>Plant size</th>
<th>With virtual prices of inputs</th>
<th>With shadow prices of inputs</th>
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<td>Ranking</td>
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<td>112</td>
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<tr>
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### Table 11: Hypotheses of geographical distribution of the market for non-flat rolled steel products

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### Table 12: Total national virtual and shadow cost indexes for the production and distribution of non-flat rolled steel products

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<th>11</th>
<th>12a</th>
<th>12b</th>
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<td>101</td>
<td>100</td>
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</tr>
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</table>

| B. National total with shadow prices                  |            |   |   |   |   |   |   |   |   |   |    |    |     |     |
| 1          | 107         | 108 | 105 | 105 | 106 | 106 | 110 | 110 | 110 | 101 | 104 | 105 | 108 | 102 |
| 2          | 108         | 108 | 104 | 104 | 106 | 106 | 110 | 110 | 110 | 101 | 104 | 105 | 108 | 103 |
| 3          | 108         | 108 | 104 | 104 | 105 | 106 | 110 | 110 | 110 | 109 | 108 | 103 | 108 | 103 |
| 4          | 108         | 108 | 104 | 104 | 106 | 106 | 111 | 110 | 110 | 101 | 104 | 105 | 109 | 103 |

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## ANNEX III

### A. Relative steel costs, according to manufacturing processes and input prices

<table>
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<tr>
<th>Process/Combination</th>
<th>Siemens Martin (60-60) with oxygen</th>
<th>Electric furnace</th>
<th>E.F.F.R</th>
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<td></td>
<td>Blast furnace</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100% C</td>
<td>90% C</td>
<td>100% M</td>
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### A Relative Steel Costs, According to Manufacturing Processes and Input Prices (continued)

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### Notes
- Numbers within (68-69) with oxygen.
- WC: Weight Consumers
- A: Average
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**Notes:**
- The table appears to be a matrix with various entries marked with + symbols.
- The entries are aligned in rows and columns, indicating a systematic arrangement.
- The context suggests it might be related to a specific analysis or data setup, possibly in a scientific or technical field.
### B. Relative Steel Costs, According to Manufacturing Processes and Input Prices

#### Siemens Martin (65-75) with Oxygen

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282
## B. Relative steel costs, according to manufacturing processes and input prices (continued)

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C. Relative steel costs, according to manufacturing processes and input prices (continued)

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[Table continued on next page]
### L-D Oxygen Converter

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### Notes:
- The table above shows the relative steel costs, according to manufacturing processes and input prices (concluded).

### Interpretation:
- The table provides a breakdown of the costs associated with different steel manufacturing processes, comparing blast furnace, electric furnace, and F.F.R. costs at various percentages of output.
- Each row represents a different percentage split of the output, with the columns indicating the relative costs for each process.

### Analysis:
- The costs are likely to vary based on the specific requirements and production quantities.
- Understanding these costs is crucial for optimizing the manufacturing process and ensuring cost-effectiveness.

### Conclusion:
- By analyzing the data presented, one can make informed decisions regarding the most cost-effective manufacturing process for their specific needs.
### D. Relative Steel Costs, According to Manufacturing Processes and EFPB Period

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**Kolod oxygen converter**
### Table: Relative Steel Costs According to Manufacturing Processes and Input Prices (Concluded)

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<th>Electr. E</th>
<th>Coal</th>
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220
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