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GUIDELINES FOR PRELIMINARY APPRAISALS OF CAPITAL PROJECTS

Part I - General Guidelines

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ROBERT R. NATHAN ASSOCIATES, INC.
Washington, D.C.

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FOREWORD

The guidelines for preliminary project appraisals (PPA's) are designed to meet the needs of analysts in evaluation of capital projects in terms of their potential contribution to economic growth. The objective of a PPA is to provide those responsible for decision-making with an early, sound basis on which the economic merits of capital projects can be evaluated and appropriate action can be taken. The appropriate action will vary with the results of the PPA, the nature of the project, noneconomic considerations, government policies in the country in which the project is located, and -- in instances involving foreign loans and/or equity investment -- the policies of lenders and investors.

In the preparation of the guidelines, it has been assumed that the "analysts" who will use them will have had limited training and experience related specifically to economic development projects in the LDC's. However, the materials in the guidelines have been selected and presented on the assumption that the user is equipped with an understanding of basic economic concepts and/or a general grasp of the relationship of the engineering and physical characteristics to the economic costs and benefits of projects.

Analysts of the types envisaged in the preparation of the guidelines may be USAID Mission personnel, consultants, economic and technical personnel in the governments of LDC's, and private organizations interested in lending to or investing in the LDC's. The guidelines are not directed primarily to the analyst with extensive experience in all aspects of definitive feasibility studies of projects. Yet such analysts may find the guidelines useful primarily in suggesting ways in which a preliminary appraisal may be conducted to provide an earlier (and less expensive) basis for staged decision-making. For the highly specialized analyst -- in a certain type of project, or a narrow aspect of the overall appraisal process -- the present document can provide useful guidelines in areas outside his own field of specialization.

It is emphasized that the guidelines for preliminary project appraisals do not provide a set of formulas which can be applied mechanically. Rather, the guidelines are intended to provide the analyst with a suggested approach that will be generally useful -- a way of thinking about projects in relation to the economic functions to be performed, the concepts, logic and tools to be applied in appraising alternatives, and the critical elements to be considered in the PPA.

No two projects are amenable to exactly the same treatment, or are influenced by the same set of factors. Thus, there is no set of hard and fast rules that can substitute for judgment, based on training and experience, in an evaluation of the potential contribution which specific projects can make to economic growth.

The guidelines are presented in two parts. The distinguishing features of a PPA, its relations to other types and stages of analysis, the basic principles and appraisal techniques applicable to all projects, and special "problem areas" are presented in Part I, General Guidelines. Part II is comprised of eight volumes, which present guidelines that deal in a more specific fashion with the physical and economic factors to be considered in the preparation of PPA's in the following sectors:

- Agriculture
- Manufacturing
- Electric power
- Water supply and sewerage
- Telecommunications
- Health
- Education
- Transportation.

I. INTRODUCTION: NATURE AND CHARACTERISTICS OF THE PRELIMINARY PROJECT APPRAISAL

The nature of a PPA can best be described in terms of its role in the general process of identifying, defining and selecting capital projects designed to maximize economic growth within limits set by specified constraints.

The purpose of a PPA is to provide decision-makers with basic information by which proposed projects can be evaluated in terms of a common denominator and priorities can be established before more expensive (in time and money) engineering studies and financial arrangements are undertaken. In a sense, the PPA is a screening device which sorts projects into three categories: (1) the clearly excellent, for which design and final appraisal can be undertaken without full-fledged feasibility studies; (2) the worthless, requiring no further analysis; and (3) the seemingly useful project requiring still more detailed analysis if the project is to move toward implementation.

Application of the procedures recommended in these guidelines will facilitate the preparation of preliminary appraisals of projects with a minimum requirement of highly skilled manpower -- usually a scarce resource in LDC's.

The Preliminary Nature of the PPA

In the typical sequence of steps leading to the implementation of capital projects, the PPA follows the identification of a need to be met, or an economic function to be performed in order to facilitate or accelerate economic growth. The identification may come in a number of ways: from a country review by an international organization, from economic studies conducted within the LDC by government with or without the assistance of foreign consultants, macroeconomic

planning or sectoral studies and/or plans,[1/] or from prospective private investors seeking government approval for specific projects. The approval sought may, for example, be for tax concessions, government loans, allocations of foreign exchange, government guarantees for foreign loans or subsidies of various kinds.

Proposed projects will show a wide range of variation in the extent which analysis has been undertaken prior to the point at which a PPA is to be made. In some cases, a proposed project may represent little more than an intuitive judgment, or hunch, that the proposed capital investment will make a significant contribution to national economic development or provide a profitable investment for the promoters. In other instances, a proposed project may have been developed on the basis of a more detailed examination of the physical requirements and the economic and financial prospects. Obviously, projects in the former category will require a somewhat different approach in the PPA than will be appropriate in the case of projects in the latter category. The latter may require only the verification of earlier analyses, an examination of alternatives and, most importantly, the application to the proposed project of criteria and standards that wil permit its evaluation, relative to other projects, in terms of its contribution to national economic growth. Regardless of the degree of background information with which the PPA begins, one of its major objectives is to bring the analysis to a point that will permit decision-makers to make sound comparisons among the various projects under consideration.

Succinctly, a PPA is an examination of a proposed capital project to determine its technical, economic and financial feasibility; to ascertain its merits and limitations (technical, economic and financial) relative to alternative ways of meeting the identified economic function, or need; to provide a basis for decision on future action to be taken on the proposed project; and, if an additional feasibility study is indicated, to specify the additional information required in order to carry out such studies.

1/ The special relations of the PPA to macro and sectoral planning studies are discussed below.

PPA's are properly directed to a searching analysis of alternative means of meeting an identified need, or socioeconomic objective. Presumptively, the costs and benefits of the project can be quantified in economic terms. But seasoned qualitative judgments and insights are also important inputs in a PPA.

Thus, a PPA will come early in the life cycle of a project, after the identification of an economic function, or need. At this stage, the results of the PPA will serve as the basis for the decision on future action on the project. The results may take one of the following forms:

1. Available information has been adequate to establish that the project is clearly feasible technically, economically and financially; that in terms of economic criteria it is the best available alternative to meet the need, or perform the identified economic function; that the project offers a rate of return superior to the minimum standard set for the economy; and that margins of error in PPA estimates of costs and benefits are so small that more detailed engineering cost analysis will not materially alter the measure of economic returns from the project.

In these circumstances, the appropriate recommendation, based on the PPA, might be to proceed to the project design and final appraisal stage.

2. On the basis of the available data, the project appears to be feasible, but only conditionally so. Critical parameters affecting costs or value of outputs cannot be ascertained with certainty in the PPA; or, the project would be feasible only on condition that government policy be modified, or that some other project be implemented.

In these circumstances, the project should be submitted to a definitive feasibility study if further consideration is to be given to project implementation. In this case, the PPA should make explicit the data requirements or conditions to be met and recommend a scope of work for the full feasibility study.

3. In the course of the PPA, an examination of alternatives may disclose that the project -- as originally proposed -- represents less than the best means of achieving the objective, or performing the specified economic function.

In these circumstances, the PPA should formulate a modified or substitute project which is the best alternative. The modified or alternative project might or might not be subjected to a full feasibility study, depending upon the factors discussed in paragraphs 1 and 2, above.

4. The PPA may disclose that the proposed project fails to meet minimum standards by a margin sufficiently large to indicate it should be rejected (at least on economic grounds) without further analysis.

In general, a favorable finding from the PPA would be followed by a full-scale, definitive feasibility study if one or more of the following conditions exists:

1. The real economic benefits of several mutually exclusive projects differ by such small amounts that margins of error in the data could influence the ranking of the projects. Therefore, more precise data, particularly engineering-cost data, are required.

2. When the real economic benefits of the "best" available project are only marginally greater than the real economic costs, <u>and</u> data used in the PPA are deficient in some important respect.

3. When the project in question is a highly complex one, or involves a large capital outlay for which more precise (than available from the PPA) cost data are required in order to obtain financing.

In other circumstances, it is generally possible to reach a decision to go directly from a PPA to the detailed engineering and design stage of project preparation. However, the three exceptions noted above are likely to be encountered fairly frequently in PPA's. Therefore, in all but the most favorable circumstances PPA's will not replace full-fledged feasibility studies.

Relation to Feasibility Study

A PPA is a type of feasibility study. Both have as their objectives the evaluation of capital projects in terms of their technical, or engineering, economic and financial feasibility. A PPA differs from a full-fledged feasibility study in the following respects:

1. The PPA is undertaken at an earlier stage in consideration of a project. A feasibility study may or may not follow a PPA, depending on conditions discussed earlier.

2. The PPA will give greater attention to consideration of alternatives than can be done in a full-fledged feasibility study.

3. Somewhat greater flexibility in modification of projects is possible at the PPA than at the full feasibility study stage.

4. The PPA must be based on sufficiently comprehensive engineering and technical analysis to permit order of magnitude estimates of the value of inputs. Yet the emphasis in the PPA is on analysis of the economic and nonengineering factors that enter into the project appraisal. In contrast, definitive feasibility studies will place much heavier emphasis on engineering and technical analysis, particularly to narrow the range of cost estimates.

Capital Projects

In the context of a PPA, a "capital project" is defined as the construction, equipping, expansion or alteration of a physical facility, including such managerial, advisory or training services as may be undertaken as an integral part of the project. Thus, PPA's are concerned with proposals involving outlays on physical assets, as distinguished from development expenditures -- such as technical assistance programs -- designed to improve the performance of some aspect of the economy, or of government administration. Expenditures for both technical assistance and capital projects are investments in the sense that both involve the early use of resources to obtain benefits in later periods.

As a practical matter, capital projects and technical assistance are often complementary components of development projects. One may be weakened or be unjustified without the other. In some cases, an economic need or function may be better, or more economically, satisfied by technical assistance than by outlays to provide new or additional physical assets -- and vice versa. For example, an educational objective, say, an increased number of graduates of post-secondary vocational schools, may require additional buildings and equipment; or it may require only a restructuring of curriculum, retraining of teachers, and an improved counseling service. More likely, some of both may be indicated by a PPA undertaken, initially, to evaluate a proposed capital project.

The Steps in Preliminary Project Appraisals

A PPA may be further explained by a brief description of the steps involved in such an analysis, and by noting certain limitations of the PPA. A PPA:

1. Ascertains and investigates the principal technical and engineering requirements for the project and determines that there is a reasonable prospect that these requirements can be met. If questions of technical feasibility are not resolved the PPA specifies the nature of the investigation required to resolve them.

2. Identifies, quantifies and places a value on inputs including construction, machinery and equipment as well as labor, materials, and supplies for operations; and major outputs, including intangible, indirect and external benefits insofar as these can be quantified or at least evaluated in meaningful terms.

3. Determines the technical manpower and managerial capabilities required to implement the project and ascertains the availability of the skills and experience available to meet the requirements.

4. Establishes the relationship of the project to other projects -- backward and forward linkages, multibusiness complexes, and infrastructure. It establishes what must be done in related fields if the project under review is to

succeed. It also makes clear what benefits the project will bring to related activities.

5. Indicates the rough order of financing needed for the project -- in domestic and foreign currencies.

6. Makes explicit the principal public policy decisions relevant to the project, e.g., tax exemptions, tariff protection, export subsidy, commitments to financing and infrastructure.

7. Examines the political and social context in which the project must be appraised, but deals in depth with these matters only insofar as they are likely to affect importantly the success of the project.

8. Assesses technological and environmental effects of the project; indicates those aspects requiring more thorough study; and estimates the costs required to eliminate or minimize adverse environmental effects.

9. Examines alternative means of meeting the economic and technical functions specified in the project, including modification in scale or timing of the project.

10. Draws a conclusion regarding the project's feasibility based not only on the analytical techniques employed to determine technical, economic and financial feasibility, but also on the analyst's perception of other factors which are critical. Qualitative judgments are called for in preliminary appraisals, e.g., in appraisal of managerial capabilities and institutional constraints.

11. Based on the nature of the conclusions, the reliability of the data base, and the characteristics of the project, formulates recommendations for the "next step" in the process of project selection.

The PPA demands precision in the approach to the project: what costs, policies, timing, inputs and outputs, and linkages must be considered; what key hurdles have to be identified; what impact will the project have; which groups are

most likely to be affected; and which methods of analysis are most relevant? It does not demand a high order of precision or great depth of investigation of the engineering aspects of projects. But because crude data may be used, it does require some measures of sensitivity -- what margins of error can be tolerated without upsetting the conclusion of the PPA?

Virtues of the Preliminary Project Appraisal

The early readout of project feasibility made possible through the PPA is one of its virtues. Another already alluded to is the economy it promises -- a judgment rendered at much lower cost than required for a feasibility study. Still another is that it helps to keep options open; allocation of substantial time and funds to a feasibility study implies a rather greater commitment to the project than does a far less involved preliminary appraisal.

There are still other virtues to the PPA:

1. A sound basis is created for selection among the many candidates for feasibility studies. A project promising a 15-percent return merits further consideration sooner than one promising a 10-percent return -- other matters being equal, of course -- provided the numbers mean the same thing. Use of an approved methodology -- the PPA methodology in these guidelines -- will help to assure comparability.

2. The PPA facilitates consideration of a wider range of alternatives than would be practical with full-scale feasibility studies; the scope of the investigation can be more broadly drawn, and more projects analyzed with given inputs of time and expenditures. Thus, the PPA is a valuable means for screening projects and concentrating full-fledged feasibility studies on only those projects for which the circumstances discussed above require the refinement of a definitive feasibility study.

3. The critical considerations involved in a project appraisal become clear sooner to the interested parties -- the progenitor and the decision-maker, the borrower and the lender. A dialogue can then develop more quickly on what additional information is needed and what policies need to be settled.

4. The PPA can help remedy a common failing of feasibility studies -- the failure of the scope of work to define realistic objectives and work programs, the depth of exploration required, the orders of precision needed. The knowledge developed by the PPA is useful in putting these matters into proper perspective, and in providing a better basis for allocation of scarce technical personnel and financial resources to feasibility studies.

5. PPA guidelines provide a common operational basis for USAID Mission personnel and their host-country counterparts for early appraisal of proposed projects. Once acceptance in principle is reached on the approach set forth in the guidelines, the opportunities for cooperation across disciplines and organizations are greatly increased, and the results of project appraisals will gain in comparability.

Can There Be a Common Approach to Project Appraisal?

The manner of carrying on a PPA necessarily will have to vary among sectors. Yet the logic and the engineering and economic yardsticks for project appraisal should be relatively consistent among sectors and projects. In order to maximize economic growth, a unit of new investment in an industrial project should yield the same rate of return as a unit newly invested in an agricultural project. If the return in industry is 2 percent and the potential return in agriculture is 12 percent, resources should be shifted toward agriculture. The application of a uniform standard in comparisons of projects in all sectors will facilitate identification of those investment opportunities offering the most favorable prospects for economic growth.

While each project will present a unique set of factors to be considered, the logical framework of analysis and the methodology recommended for assessing the economic merit of projects have general applicability. From the standpoint of a PPA, the most significant differences among projects relate to their physical -- engineering and technical -- characteristics and to the ease or difficulty with which project outputs can be quantified and valued. Discussions of the distinctive features of projects are confined, largely, to Part II, Sectoral Guidelines. Those elements in the PPA that are more or less common to all sectors are presented in Part I, General Guidelines.

Relation of Preliminary Project Appraisals to Other Economic Studies

A PPA must be made in the light of the ongoing development process and of general economic, political, and institutional factors. Annual budget messages, economic development plans and programs, input-output studies, national income and GNP data, and reports of Ministries and government departments can provide much of the general background material useful in a PPA. Political and sociological studies may also provide relevant background.

The analyst must consider how the project will be affected by developments in the economy generally and also in politics, and by cultural patterns in the country. A reasonably detailed macroeconomic plan or a good sector plan in which the project falls can be most useful if available. But frequently such plans are not available; the analyst may himself have to make estimates of past and prospective economic data vital to the project appraisal; for instance, trade data. (His estimates may be simply done, e.g., based on extrapolations of past trends. It is important, however, that he make clear just what he has done.)

Macroeconomic Studies/Plans

What kinds of macroeconomic data and guidance should the project analyst be looking for? They are of two kinds:

- Past and projected measures of economic aggregates
- An understanding of the development strategy for the country.

The PPA should examine only key aggregative data. Examples are:

1. Fiscal, monetary, and foreign exchange data. These will point to tax burdens, credit availability, ease of access to foreign exchange, exchange controls, and so on.

2. GNP and national income data. Such data are useful as a basis for estimating market demand for many final products and services. If input-output (or interindustry relation) studies are available, these can be useful in estimating future requirements (demands) for intermediate goods, e.g., raw materials, machinery, equipment, supplies and services used in production.

3. The size, content, and deficit or surplus position of the budget. These will affect the availability of government funds to finance public projects.

4. Regional development plans as they influence the location and size of projects.

5. Policies affecting the "openness" of the economy - tariffs, licensing, investment controls.

The strategy of development must also be considered in the PPA, as it will establish conditions and constraints that will affect how projects can be put together and be implemented. How does the project fit into the strategy?

Some important elements of strategy that affect sectors and projects are:

- Import substitution, export emphasis
- Inflation
- Incentives and disincentives for new activities
- Relative emphasis on industry, agriculture, infrastructure
- Reliance on market prices or price controls, fixed and overvalued exchange rates
- Domestic and foreign borrowing
- State ownership of enterprises
- Nationalization of enterprises, diminution of foreign control over local enterprises

. Emphasis on creation of employment opportunities, extent of unemployment, underemployment.

A few examples will point up the significance of the elements of development strategy for the PPA:

. The strategy on "prices." Will the government let the free market point the way to decisions by consumers and investors, or will it seek to shape those decisions by price ceilings, subsidies, fixed exchange rates, allocations of foreign exchange, etc.? Can the effects of such shaping be predicted? And what will be the impact on the project if the government should take a greater or lesser hand in the shaping of such decisions than the analyst foresees?

. Foreign exchange rate policy. If the government follows a policy of maintaining an official rate of exchange that overvalues the domestic currency -- perhaps in the hope that such a policy will restrain domestic prices of imports or make it easier for borrowers to repay foreign loans -- the analyst must take this into account. Where foreign exchange is rationed, there will be great uncertainty regarding supplies of imported materials and equipment unless the industry concerned is accorded high priority. Such policies will also make it more difficult to develop export markets on a long-term basis.

. Incentives and disincentives for projects will affect their viability. Is the project of the kind to merit exemption from import duties, tariffs, limits on imports of competing goods, easy credit, subsidies, etc.?

. Does the strategy favor concentration in certain fields? Is agriculture a heavily emphasized sector? Does the irrigation or livestock project fit well into the overall strategy for agriculture?

. Regionalism. Does the industry project reflect the country's strategy to engage in regional integration as in Central and Latin America and in East Africa?

To the extent that the policies underlying the government's development strategy can be known, they should be regarded as part of the socioeconomic framework into which a project must fit if it is to have a reasonable chance for survival.

The Sector Study

The term "sector," as applied to economic studies or plans, means a part or component of the economic system identified in terms of the nature of the output of the units comprising the sector. In the simplest sectoral studies, the economy may be broken down into only two subaggregates: (1) agriculture, forestry, fishing and hunting, and (2) all other activities. Two-sector analysis may provide some insights into the economy not available from the aggregates, but it will not provide much more. As disaggregation is carried further, the number of sectors increases, and the analyst is able to have increasingly precise knowledge about a smaller and smaller portion of the economy.

Sectoral studies are concerned with quantitative analyses and qualitative descriptions of specified components of the economy, e.g., the agricultural sector, the power sector, or the wood products and furniture sector. Typically, such studies include:

1. Demand-supply estimates, including analyses of the determinants of demand, existing and planned capacity and constraints on increases in supply.

2. Unit cost and price information.

3. Import-export relations in the sector.

4. Intersectoral relationships, e.g., sources of supplies of raw materials and intermediate goods, and sources of demand for output by other producing sectors, final consuming units and by foreign buyers.

Where satisfactory sectoral studies have been made, they constitute sources of directly useful information, e.g., estimates of future demands for a relevant category of goods, cost and price data, and the more important backward and forward linkages. In fact, a careful examination of sectoral studies, particularly if such studies have incorporated intersectoral demand-supply relationships, may provide the "identified economic functions" for which sound projects can be designed.

Sectoral studies and plans are especially useful in a PPA as a guideline in the systematic examination of alternatives. Should the project be postponed to a later stage in development? (The answer may depend on the rate of growth in sectoral demand -- or an anticipated change in an existing source of supply.)

Should a proposed chemical plant be modified to produce more raw materials for man-made fibers, and less for fertilizers? Again, sectoral projections may suggest the modification that will enhance the contribution the project can make to economic growth.

Again, the existence of unutilized capacity in a sector may suggest a project that can provide a (socially) profitable alternative to idle plant and equipment.

While sectoral studies are receiving increasing attention in LDC's, the analyst is not likely to find a relevant study of the sector in which the project falls. If this is the case, it will be necessary to resort to whatever fragmentary data are available, e.g., records of imports (exports) of goods similar to those to be produced by the project; or surveys, samples, or census enumerations that may provide at least a limited basis for estimates. Production and consumption of specific classes of commodities in a given country also may be estimated from statistics from other countries at a similar stage of economic development, provided the two countries are not characterized by such dissimilar climates, cultures or political controls as to invalidate comparisons.

Sector Plans and PPA's

While PPA's are facilitated by the availability of macro and sectoral plans, PPA's can also make an important contribution to the formulation of investment budgets and such plans. Many plans are formulated from the "top down." Macroeconomic models are employed to set overall growth targets in terms of GDP or GNP, and to arrive at internally consistent projections of consumption, savings and investment. At the sectoral level the macroeconomic plans may call for emphasis on growth in this or that sector, and project a balanced or unbalanced relationship among the sectors.

Alternatively, planning from the "bottom up" proceeds from the identification -- and some type of screening -- of projects, to aggregation on the sectoral and total economy levels. Either approach alone yields less than a satisfactory base for economic planning. Both approaches are required; the PPA can serve as a relatively inexpensive method of screening prospective projects (explicit and implicit) from the largely untested list which many economic plans contain.

II. FUNDAMENTALS OF PROJECT PREPARATION AND APPRAISAL

Project preparation requires essentially three sets of estimates:

1. Estimates of annual outputs over the life of the project, based on the planned capacity of the project, the levels of future "demand' for the output, a d the existing sources of supply

2. The estimated annual flow of resources, or inputs, required to produce the estimated outputs

3. The physical quantities of inputs and outputs, multiplied by appropriate unit prices to obtain an estimate of annual money flows, or annual costs and benefits expressed in monetary terms.

From these basic estimates, projects are evaluated in terms of their rates of return.[1/] In order to receive further consideration, a particular project must not only meet a specified minimum rate of return, it must also offer the best rate of return of any available alternative form of the project to supply the good or service.

Estimation of Output for Salable Products or Services

In general, projects fall into two categories:

1/ Various measures of "rates of return" are discussed in appendix A; the rates of return recommended in these guidelines are defined and explained in chapter III.

- Those producing outputs of goods and services that can be sold for a price to buyers who can take or leave the good as their individual preferences dictate, and

- Those producing goods and/or services for which the demand is determined through some form of collective decision -- usually through government, e.g., public education and health projects. Decisions with respect to the quantities and kinds of these services to be produced are not based on market demands. Rather, such demands or needs are based on population trends, the ability of the country to provide the service, and the decision-makers' views of the society's ranking of priorities.

Market Demand for Output

Estimation of future market demands for particular outputs must begin with data (or estimates) of quantities demanded in relevant past periods. These can usually be obtained from one, or some combination, of the following sources:

1. Domestic producers and/or importers and other middlemen

2. Tax records, if the article is one on which taxes are imposed and collected

3. Import statistics, if in sufficient commodity detail, and if there are not too many exemptions from duties and nonrecorded imports

4. Household budget studies

5. Requirements of industrial and governmental users. (This source of information is essential for intermediate goods.)

6. If other sources are inadequate, estimates may be made from data available for other countries having similar industrial structures, per capita incomes and population, and political and cultural characteristics that would affect demand for the product in question.

Where sectoral demand studies have been made, these will be useful as benchmarks; if commodity supply-demand studies for products to be produced by the project have been made by the central planning authority, these should be used. Given a satisfactory estimate of current demand, the next step is to project this over a future period corresponding to the life of the project.

Estimation of future demands for specific products, or groups of products, is difficult under the most favorable statistical circumstances. The difficulties are compounded in most LDC's by the lack of historical data and especially by the discontinuities in demand relationships that occur in a rapidly developing economy. Nonetheless, the task must be undertaken. The following approaches are suggested:

1. Projection of past trends, with adjustments for anticipated changes that are expected to alter historical relationships. Extrapolations of time trends are notoriously hazardous; past relationships between the demand for a particular good and some other economic variable, such as projected GNP, total consumption or industrial production, usually provide a better base for extrapolation than projection of a time series.

2. If available, coefficients derived from an input-output matrix can be used in the projection of demand, particularly for intermediate and primary goods. It is well to bear in mind, however, that economic development implies new technologies and changing structure of the economy. Both can affect the reliability of coefficients derived from historical interindustry relationships.

3. For consumers' goods, family budget studies by income groups and by rural-urban categories can be used to extrapolate present patterns of consumption, providing projections of future income patterns and the rural-urban composition of households are available.

4. International comparisons may also be helpful in projecting future demands. The future level of demand for particular goods in the subject country, say, in 1990, may be inferred from the demands in other comparable countries that reached -- in the recent past -- the level of economic development (per capita GNP, industrial structure) projected for the subject country in 1990. Several countries, rather than one, should be used in such comparisons.

5. Total demand should also reflect potential foreign demand if the project is one having an export potential. The quality, price and reliability of delivery are critical factors in appraising the potential for exports.

When projections of total demand for the product(s) have been made, the "share of the market" that can be expected to be available to the project must be estimated. From the total projected demand, the projected quantities to be available from existing and definitely planned sources of supply should be subtracted. The remainder is the supply gap which the project is to fill, in whole or in part.

If current demands for the product are being met by imports, the feasibility of import substitution requires to be considered. Can the project under consideration produce a substitute for the imported product that will be competitive in quality and price? In terms of the economy as a whole, what will be the real costs of subsidies, tax concessions, tariff and nontariff restrictions on imports required to make import substitution viable?

Projections of Requirements for Nonmarketable Outputs

As noted previously, many projects will involve outputs which are not sold for a price, or are assigned only nominal charges that are not expected to cover total costs. Typically, such projects are public projects -- education, health facilities, public amenities and some economic infrastructure, such as roads and communications facilities.

Estimates of the "demand" for such outputs are generally based on:

- Estimates of the number of future users of the service, e.g., the school-age population, projected traffic, population densities, etc.

- The required level of service, e.g., the quality of education; the speed, safety and economy of vehicle operation provided by a road, etc.

The level of service is generally determined in the light of budgetary constraints, availability and terms of borrowed funds, prevailing attitudes in the society, and the competing requirements for public expenditures.

The particular method for estimation of the demand, or need for services of this type will be different for most services. The following are illustrative rather than exhaustive.

1. Education services. Projected school-age populations, percent of the projected population expected to attend (based on location of population, emphasis placed on education in the society, economic constraints on attendance), anticipated employment opportunities for school leavers, and expected changes in income. Medium-term forecasts of school-age population are relatively simple if present population by age levels is known and reasonably accurate mortality tables are available. Attendance ratios are less readily predicted. In projecting the current attendance rates into future years, effects of anticipated rural-urban population shifts, improved transport facilities and rising income levels, especially among lower income families, should be taken into account.

2. Public health facilities. In most LDC's, the availability of health services is far below the levels considered acceptable, even in terms of conservative standards. Evaluation of the "demands" for such services is more properly focused on the government's ability to finance, staff and operate the proposed facility, and the "appropriateness" of the proposed facility for the accomplishment of the program.

3. Transportation facilities. While the use of publicly provided transport facilities -- such as roads and ports --frequently involves a payment in the form of a toll or other user charge, the determination of the "demand" for such facilities is not made through conventional market channels. Rather, projects are appraised in terms of such factors as: anticipated increases in the demand for transport services; their contribution to reductions in costs of passenger and freight transport, including -- where relevant -- savings in time; economic development, where lack of transportation is a critical constraint; and political, social and economic integration.

The valuation of outputs of this type presents very difficult problems. These are discussed in greater detail in chapter V and in the individual sector guidelines. Here it is noted that PPA's for projects of this type are sometimes confined to a determination of the least-cost alternative capable of supplying the quantity and level of service required; or, preferably, a cost estimation for a range of quantities and/or service levels should be prepared by the analyst. On the basis of such estimates, decision-makers can evaluate alternative scale of projects to provide a given service, and the opportunity costs, to the public authorities, of different services.

Physical Resource Flow Plan: Estimating Inputs

The study of the "market" or the "need" for the goods or services, utilizing one or some combination of the approaches described earlier, will indicate the nature and sizes of projects meriting further analysis. The next step involves the preparation of a physical resource flow plan indicating the physical inputs and outputs during each year over the life of the project. The composition of inputs will be determined by the nature of the good or service to be produced, the technology selected for application in the project, the method and time schedule for construction, etc.

Cost Estimation

Although PPA's require significantly less detailed and extensive engineering data than a full-fledged feasibility

study, the data base must be adequate to permit at least order-of-magnitude estimates[1/] of construction and operating costs. The amount of engineering required in the PPA will depend, in part, on the type, quantity and reliability of data already available.

For the fixed capital component, the quantities and unit prices employed in estimation of costs should be based on engineering investigation of the construction site, and other factors that will exert a major influence on costs. These include:

1. Skills and productivity of local labor

2. Local climatic conditions as they affect productivity of labor and machinery

3. Availability and quality of local construction materials and machinery

4. Local building standards

5. Indirect costs and overheads during construction.

Cost estimates should be prepared in such a manner as to show separately the foreign and domestic currency costs. The checklist presented in appendix C cites the principal factors to which engineering expertise should be directed in the PPA.

Estimation of operating and maintenance costs during the life of the project should also be based on engineering assessments of physical inputs and probable requirements for repairs, overhauls and general maintenance. In order to obtain reasonably accurate estimates of these inputs, it is

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1/ Order-of-magnitude estimates are made without detailed engineering. It is expected that such estimates will have an accuracy within plus 50 percent and minus 30 percent. (See Appendix B.)

essential that engineers familiar with the proposed production or operating process be available for consultation on the physical input schedules.

In a PPA, the units for estimation of costs should be in the form of modules or aggregates that lend themselves to short-cut estimation, e.g., costs per mile of road construction, by type of terrain and by service standard. However, great care must be exercised in converting module costs to local conditions. The usefulness of modules for estimating purposes will vary considerably from sector to sector.

Construction costs in LDC's are sometimes estimated by applying "country correction factors" to unit costs compiled from actual experience in other countries.

Short of detailed engineering -- which is beyond the scope of the PPA -- the most reliable basis for estimation of costs is from similar projects that have been carried out within the country in the recent past. Even dissimilar projects may contain many common components for which unit cost comparisons will be valid, e.g., excavation, land clearing, grading, erection of general purpose buildings, supplies of gravel, sand, cement and other local building materials. Since it is the local element of costs -- not the unit cost of imported materials, machinery, equipment and supplies -- which shows the greatest country-to-country variation, the degree of accuracy required in PPA cost estimation can frequently place comparatively heavy reliance on local, in-country cost experience, thus minimizing but not entirely dispensing with detailed engineering inputs at this stage.

Pricing Inputs and Outputs

If a project is being appraised from the standpoint of the profitability or rate of return to the enterprise, all inputs and outputs are priced at market prices.[1/] Taxes paid are treated as costs, while subsidies received are entered as receipts (benefits) in computation of the rate of return.

1/ Averaging of prices may be undertaken to avoid distortions. See appendix B.

However, a PPA to determine the net benefit, or rate of return, to the economy as a whole measures inputs and outputs in terms of "real costs" and "real benefits These may or may not be measured accurately by market prices. If not, "shadow," or accounting, prices are used in place of market prices.[1/] Computation of the rate which projects contribute to the national economy excludes taxes from the costs of inputs and subsidies from the value of outputs -- both being regarded as "transfer" payments rather than payments for the use of productive factors, or for benefits flowing from the output.

In LDC's, markets for many products are highly imperfect as a result of limited number of buyers or sellers, price determination by administrative action, and compartmentalization of markets because of inadequate transport and communication. Prices in such markets are an imperfect guide, at best, to the estimation of the national economic value of output from prospective projects.

Where output will consist of marketable products (i.e., divisible goods which can be sold for a price) and such goods are traded in world markets, the c.i.f. price (exclusive of duties) provides a satisfactory base for valuation of domestic output -- if a "correct" exchange rate is employed in converting the foreign to the domestic currency value. If both nonlabor inputs and outputs consist largely of goods traded in world markets, it may be desirable to use world prices for the computation of a project's rate of return to the economy, with labor and other domestic inputs converted to world prices by use of the accounting rate of foreign exchange.

While there is no completely satisfactory method of determining "correct prices" in the absence of reasonably free, competitive markets, the analyst should be alert to the price distortions arising from such factors as those cited above, from clearly temporary shortages, and from disruptions in supply and inflation. By using accounting prices rather than actual prevailing prices, estimates can be improved in these circumstances.

1/ The estimation and use of shadow, or accounting, prices are discussed in appendix B. The concepts "rate of return to the enterprise" and "rate of return to the economy" are contrasted in the following chapter.

In general, inputs and outputs should be valued at constant prices. But it is important to make allowance for probable future price changes that will result if the project under review will provide a large addition to the short supply of a good having an inelastic demand. For example, the value of output of large-scale agricultural projects can all too easily be overestimated by failing to take into account the effects of increased agricultural output on prices during the life of the project.

External Costs and Benefits

There are certain inputs (discussed in detail in a later section) the costs of which are not actually paid by an enterprise. The inclusion of such costs is appropriate if the project is being appraised from the standpoint of the rate of return to the economy, because these costs are borne somewhere in the economy. For example, air and water pollution may impose real costs on the population in the form of loss of production through illnesses and medical expenses.

An analogous situation exists with respect to outputs (benefits) on which an enterprise is not able to impose a price and, therefore, collect revenues. In some types of projects, e.g., development roads, the external benefits may be so important that the proposed road can be properly evaluated only by consolidation with the land development schemes or other development it will serve.

III. APPLICATION OF CRITERIA IN PROJECT APPRAISALS

The ultimate purpose of project evaluations (at all stages including the PPA) is to provide a basis for the selection for implementation of those projects that will make the maximum contribution to economic growth. The process of identification and selection is facilitated to the extent that quantifiable costs and benefits attributable to projects -- differing in size, duration, type of output and technology employed -- are expressed in terms of a common measure or measures. This will permit meaningful comparisons of the financial and economic aspects of projects having widely varying characteristics.

The pricing of physical inputs and outputs, discussed in chapter II and in appendix B, is the first step in the process of providing a common basis for aggregating inputs and outputs and for comparison of dissimilar projects. Unlike physical inputs, e.g., man-hours of unskilled labor, tons of cement, transformers and office machines, aggregate inputs can be added to a meaningful total only if each is multiplied by a price to obtain a value. The same basis for aggregation is applicable to outputs.

A second step in the development of a "common denominator" in terms of which projects can be compared involves discounting.

Discounting

Discounting is the process by which the monetary values of inputs and outputs, or the differences between inputs and outputs, occurring at different points in time are expressed in terms of a common denominator: their present values.

An output (receipt) this year is more valuable than the same output 10 years hence. Similarly, a cost incurred 10 years hence is less burdensome than today's. Discounting provides measures of the present value of inputs and outputs no matter when they occur during the life of a project. In essence, discounting makes it possible to answer the question: How much is a specified net earning x years hence worth today?

The distribution of the values of inputs and outputs through time will be different for various projects. Projects yielding a surplus in the near future are more desirable than those yielding the same amount of surplus in the more distant future. Therefore, the discounting procedure is essential if two or more projects are to be ranked, or if a particular project is to be compared with an economy-wide standard of acceptability.

Discount rates are based on the compound interest concept relating present and future values. Letting V_o represent present value, and V_n the value of V_o n years in the future, the following relationships may be noted:

$$V_n = V_o(1+r)^n$$

then

$$V_o = \frac{V_n}{(1 + r)^n},$$

or present value = value n years in the future divided by the "discount rate," i.e., $\frac{1}{(1+r)^n}$.

In practice, the values of $\frac{1}{(1+r)^n}$, the discount rate, are read from standard tables for the selected r and number of years. Two such tables are presented in appendix D: table D-1, "Single Payment Present Worth Factors"; and table D-2 "Continuous Flow Present Worth Factors at Annual Rates."

Selection of Discount Rate

The appropriate discount rate depends upon the context in which a project is to be appraised. If the appraisal is in terms of the discounted benefit-cost relationship viewed from the standpoint of the national economy as a whole, the

appropriate discount rate is the accounting or shadow rate of interest, i.e., the marginal opportunity cost of capital in the economy (see appendix B). On the other hand, if a project is being evaluated from the standpoint of its "profitability" as an enterprise, the discount rate should be the rate required to attract the required capital. In the examples that follow, it is assumed that the discount rate represents the marginal opportunity cost of capital.

The discount rate must be selected in advance in the application of the discounted benefit-cost ratio, and the discounted present value of net benefits criteria; in principle, it is not necessary to select a discount rate in order to compute the internal rate of return on a project. In practice, however, as will be shown in the following examples, the internal rate of return computation is usually made by selecting discount rates approximating the internal rate, and interpolating for the actual internal rate of return.

Project A: An Illustration

The application of discounting, and computation of internal rate of return, are illustrated in the following paragraphs. More detailed illustrations of computational procedures and descriptions of the criteria generally employed in project appraisals are presented in chapter VII and appendix A.

Before turning to the illustrations, it is noted that the techniques are applicable to any series representing a flow of values (inputs, outputs, or outputs minus inputs) over a period of time. In the illustration, the time period is taken as 1 year; other periods can be used, with appropriate r's.

Assume the following values for inputs, outputs and surpluses (deficits) for a proposed project, A:

Project A

(in thousands of dollars)

Year	Inputs	Outputs	Surplus	Discounted surplus[a] at 10%	Discounted surplus[a] at 12%
1	300	0	-300	-272.73	-267.87
2	400	0	-400	-330.56	-318.88
3	75	150	75	56.35	53.39
4	70	150	80	54.64	50.84
5	75	200	125	77.61	70.93
6	85	225	140	79.03	70.93
7	90	250	160	82.11	72.37
8	110	300	190	88.64	76.74
9	110	300	190	80.58	68.51
10	110	350	240	92.52	77.28
Total	1,425	1,925	500	8.19	-45.76

a/ The discount rates, expressed as $\frac{1}{(1+r)^n}$, are shown for various values of r in appendix D.

In Project A it is assumed that all investment of $700,000 occurs in the first and second years, with no output in either year; that the expected life of the project is 10 years; and that the plant and equipment will have a scrap value of $50,000 at the end of the tenth year. This amount has been added to revenue from sales of output ($300,000) in the final year. It is also assumed that the capacity of the project at the projected price is $300,000 per annum; and that in the initial year of operation (third year of project life) production reaches only 50 percent of capacity, rising gradually to reach full capacity in the sixth year of operation (i.e., the project will have excess capacity in the earlier years of operation).

Over the life of the project, the total value of inputs (capital and operating), before discounting, is $1,425,000; total revenues, including scrap value, are $1,925,000. The undiscounted surplus flow is $500,000 -- with a present value of only $8.19 thousand if discounted at 10 percent, and a negative present value of $45.76 thousand if the discount rate is 12 percent.

Several features of the procedure illustrated above merit comment.

- In the first place, it is not necessary to draw a distinction between capital outlays and current outlays, both being treated as inputs in the year in which they occur.

- Second, interest paid and depreciation are not recorded as inputs, i.e., as costs.

- Third, if the economically useful life of the project will extend beyond the period for which the discounting is being done, the estimated value of assets at the end of the final discounting period can be entered as a negative input or as an addition to output.

The Internal Rate of Return

The internal rate of return (IRR) is the discount rate which equalizes the present values of the streams of inputs and outputs -- or, in the illustration, which would reduce to zero the algebraic sum of the stream of discounted surpluses (deficits). Thus, if the algebraic sum of the flow of discounted surpluses and deficits is zero, the internal rate of return on the project is equal to the discount rate; if negative, the internal rate of return is less than the discount rate; and if positive, the rate of return is higher than the discount rate.

Clearly, on the basis of the hypothetical flows, Project A is worthy of further consideration on purely economic grounds only if the marginal opportunity cost of capital is 10 percent per annum or less. The approximate internal rate

of return on the project is just over 10 percent, as shown by the interpolation below:[1/]

$$r_i = .10 + .02 \left(\frac{8.19}{(8.19 + 45.76)} \right) = .103$$

Project B: An Alternative

Hypothetical data for Project B, assumed to be an alternate project producing the same product, are presented below for comparative purposes.

Note that total inputs, total outputs and total (undiscounted) surpluses are identical in Projects A and B.

Project B

(in thousands of dollars)

Year	Inputs	Outputs	Surplus	Surplus discounted		
				at 10%	at 12%	at 15%
1	200	0	-200	-181.82	-178.58	-173.92
2	330	0	-330	-272.71	-263.08	-249.51
3	75	150	75	56.35	53.39	49.31
4	100	225	125	85.37	79.44	71.48
5	120	250	130	80.72	73.76	64.64
6	120	250	130	73.37	65.86	56.20
7	120	250	130	66.72	58.80	48.87
8	120	250	130	60.64	52.51	42.50
9	120	250	130	55.13	46.88	36.96
10	120	300	180	63.39	57.96	44.50
Total	1,425	1,925	500	93.16	46.94	-8.97

1/ The values in the equation are the algebraic sums of the discounted values of the streams of surpluses in Project A, i.e., \$8.19 at r_i = 10 percent and -\$45.76 at r_i = 12 percent.

However, the two projects would be accorded different priorities for further analysis or for implementation. At a discount rate of 12 percent, the present value of the stream of surpluses from Project A is negative; for Project B it is positive. Thus, Project B promises a higher internal rate of return than Project A.[1/] The higher internal rate of return from Project B arises from the difference in the timing of the annual flow of surpluses. The discounting procedure measures in terms of present value -- or, alternatively, in terms of an internal rate of return -- the differing pattern of distribution of surpluses and deficits on all potential projects being appraised. It is, therefore, a critical step in project appraisal, even at the preliminary stages.

The Criteria for Project Appraisal

There are several criteria in terms of which the economic and financial returns or benefits of capital projects may be measured and compared. Three of the more commonly used criteria have been noted earlier. These are discussed, contrasted and illustrated in appendix A.

In the guidelines, it is recommended that the internal rate of return criterion be employed and that projects be appraised from the standpoint of the national economy and from a business enterprise point of view. The former will be referred to as the net national rate of return (NNRR), and the latter as the business enterprise rate of return (BERR).

The Profit and Loss Rate of Return and the BERR

Before considering the technical distinctions between the two criteria recommended in the guidelines, it is desirable to note that the BERR differs in some important ways from rates of return calculated from annual statements of profit and loss, or income statements. The analyst may be confronted with project proposals showing rates of return that have been calculated from annual profits in a "normal

1/ The interpolated internal rate of return on Project B is approximately 14.5 percent per annum.

year." In any case, in presenting the results of the PPA, the analyst will very likely find in his audience individuals whose way of thinking about rate of return matters will run in terms of conventional accounting profit and loss statements, rather than the criteria recommended for the PPA. For these reasons it is important to note the principal differences between the BERR and the profit and loss statement rate of return.

The annual profit and loss statement reflects an allocation to discrete (annual, semi-annual, quarterly, or monthly) time intervals the net income of an economic unit over its entire life. Briefly, this is done by charging as inputs the economic values used up during each period, and subtracting these from outputs during the period. This requires that assets lasting over several accounting periods be "used up" little by little, i.e., the input for a period is the depreciation, depletion, or other allowance measuring the value of the asset charged against the output of the period. It is, therefore, an expense (reducing profit). But it may also be a source of funds -- to be used to pay for purchase of other assets; for investment in securities; and for debt retirement.

Conversely, in conventional accounting a machine that will last several years is not considered as an expense when purchased, but as an asset to be written off (depreciated) as an expense over its useful life.

Annual interest payments on borrowed funds are an expense, a charge against output in the profit and loss statement. However, neither depreciation nor interest payments are recorded as charges against output in computing the BERR; rather, outlays for assets are treated as inputs in the year in which the outlay is made, while interest is treated as a residual -- the rate of earning on total assets, rather than on <u>equity</u> capital alone.

Conventional profit and loss accounts (actual or projected) serve as a useful tool for management, and as a basis for computations to measure the contributions of projects to national and enterprise growth. The use of such statements in the PPA is shown in chapter VII. However, conventional accounting statements of income are not the most useful criteria for project evaluation.

The Net National Rate of Return and the Business Enterprise Rate of Return Compared

Both the NNRR and the BERR are internal rates of return, computed in the manner illustrated earlier in the present chapter, and in appendix A. The two criteria differ in respect to: (1) the prices used in valuation of inputs and outputs; (2) the items included in inputs and outputs, and (3) the treatment of taxes, subsidies and certain other transfers.

The principal differences are as follows:

. The BERR is computed from inputs and outputs valued at actual market prices; in the computation of the NNRR, accounting, or shadow, prices are employed in lieu of market prices if the latter are clearly inaccurate measures of real costs and/or the real value of output.

. Accounting or shadow prices are most likely to be required as substitutes for actual prices in the case of unskilled labor, capital and foreign exchange. The circumstances giving rise to the need for shadow pricing are discussed, and suggestions for estimation of accounting or shadow prices are put forward in appendix B.

. Internal taxes, as well as customs duties paid by the enterprise, are treated as costs (inputs) in the computation of the BERR, and subsidies received are treated as benefits (receipts), or are netted out against the cost of an input; in computing the NNRR, taxes and subsidies are omitted, being regarded as transfer payments rather than payments for current factor inputs or outputs.

. In certain instances, real costs and real benefits attributable to projects may not appear as inputs or outputs of the enterprise, and therefore are excluded from the computation of the BERR because there is no explicit market transaction for them. However, where substantial amounts of real costs and real benefits are omitted from enterprise outlays and receipts, respectively, and where there is some means of placing a value on the costs and/or benefits, they should be included in the value of inputs and outputs used in computation of the NNRR.

. The NNRR is a measure of the economic rate of return; the BERR is a measure of the financial rate of return from a project. Decision-makers need both measures to select projects that will yield the maximum contribution to economic growth, and also to provide a guide for the design of appropriate measures for meeting the financial requirements of the project.

A project that is financially profitable -- from the enterprise point of view -- may be less than the "best" project from the standpoint of the national economy for a number of reasons, the most important of which follow:

. If the exchange rate overvalues the domestic currency, projects utilizing significant amounts of imported inputs to produce for domestic markets will tend to yield a higher rate of return to the enterprise than to the national economy.

. While the cost of capital funds to be used in the enterprise does not enter into the computation of the BERR, if the rate of interest on funds employed in the enterprise is below the marginal efficiency of capital, the project appears to the prospective entrepreneur to offer a more profitable prospect than its rate of return to the economy justifies. This situation may arise when government, for whatever reason, sets interest rates at artificially low levels; when foreign capital is available at rates lower than the marginal efficiency of capital in the country; and when serious rigidities and/or imperfections exist in the domestic capital market. In these circumstances some form of capital rationing or allocation will usually be present.

. There may be important real costs arising from the project which are not reflected in the costs borne by the enterprise, e.g., adverse effects on the health of the workers; air, water and other environmental degradations; and real costs attributable to the project but borne, financially, by other economic units -- public and/or private. In the latter category, the cost of supplying publicly financed infrastructure required to implement the project is a common source of understatement of total economic costs attributable to projects. Through taxation, government may attempt to bring the financial costs incurred by the enterprise closer to the real costs of the project to the economy.

Of greater importance, there are many instances in which projects that are unattractive, i.e., unprofitable, from an enterprise viewpoint can be demonstrated to be very beneficial in terms of a net rate of return to the national economy. These occur, most commonly, where the market value of inputs is substantially above the marginal opportunity cost of applying the input in the project in question.

For example, the money wage rates of unskilled labor in developing countries (typically experiencing serious unemployment in urban areas and underemployment in both urban and rural areas) are frequently above the marginal opportunity cost of this type of labor. Since it is market wages -- rather than the marginal opportunity cost of unskilled labor -- at which the enterprise must value labor input, the enterprise rate of return will be less than the rate of return to the national economy, all other things being equal.

The NNRR will also tend to be higher than the BERR by virtue of the exclusion of taxes as costs in the computation of the rate of return to the economy, as distinguished from the rate of return to the tax-paying enterprise. This is one of the more common reasons for the excess of the NNRR over the BERR.

Where project output includes benefits for which the enterprise is unable to charge a price equal to the full social value, the enterprise net rate of return will be less than the net national rate of return to the project.

If substantial excess (idle) capacity exists in another industry supplying an important project input such as transport, electric power, or a raw material, the rate of return to the national economy may be higher than the rate of return to the enterprise. If the price of the input is higher than the incremental cost of producing it, a benefit arising from the project accrues to the supplier.

On the other hand, a project that removes a bottleneck in the supply of a raw material critical to the operation of another industry may make a greater contribution to national economic growth than is reflected in the market value of the project's output.

The project analyst should be conscious of these possibilities; if the magnitude of such benefits is large, consideration should be given to their inclusion in the appraisal under the conditions stated below, even if nothing more than a rough quantification is undertaken at the level of the preliminary project evaluation.

Linkages and Multiplier Effects of Projects

The preceding illustrations of external benefits arising from a project but accruing to suppliers of inputs and users of outputs arise from "backward" and "forward" linkages respectively. Normally, it is not considered necessary to make a special allowance for linkage effects in project evaluation, particularly at the level of a PPA. For one thing, comparable linkage effects may be expected to flow from a number of similar projects; therefore, explicit consideration of the linkage effects would not add any important measure useful in differentiating the flow of net benefits from the projects. Also, if market prices are determined in a comparatively free, competitive manner, the benefits from forward and backward linkages attributable to a project will tend to be reflected in the market value of inputs and outputs of the project, and thus no special allowances for "external benefits" are required.

Explicit allowances for the linkage effects in a PPA would be justified only if:

- The funds available for investment in the project would not be available for investment in any other project, <u>or</u>

- The linkage giving rise to the benefit or cost, forward or backward, is uniquely attributable to the particular project under analysis, i.e., it would not occur at all, or in the same degree, if some alternate project is selected.

The conditions under which an explicit measure of the "multiplier effect" should be included in the analysis are even more restrictive. Practically, the analyst should include as a project benefit the multiplier effect on output only if the project being analyzed is the only way to increase total

demand, and inadequate demand is the only constraint on growth of output.

Reconciliation of Priorities: Enterprise and National Rates of Return

Projects promising an enterprise rate of return in excess of rates from alternative investments can generally be left to the private sector for implementation; i.e., prospective earnings will generally provide the incentive, and -- if the prospects have been correctly appraised -- revenues from the sale of outputs will provide the means to meet capital and operating costs. This result will be more likely if the projects are of modest size and prospective entrepreneurs are assured of access to the required foreign exchange.

Of more significance, there will also be projects on which a higher rate of return to the national economy is in prospect, but which offer an enterprise rate of return too low to attract private entrepreneurs or lenders. These discrepancies are most likely to be found in the following circumstances:

1. The project involves large inputs of unskilled or semiskilled labor for which the accounting wage rates (i.e., real wage costs) are substantially below the market wage rates.

2. The project will yield substantial indirect and/or intangible benefits for which a private entrepreneur cannot exact payments.

3. Output from the project is to be exported <u>and</u> the domestic currency is overvalued, <u>and</u> there is no special export subsidy.

4. Taxes comprise an important element of cost to the enterprise; because taxes are not an element of cost to the economy, the BERR will fall below the NNRR.

In the extreme cases of indivisibility of output (thus precluding rationing through price) and intangible benefits, the projects are likely to be implemented and financed through the government sector. In less extreme cases, subsidies, preferential taxation, privileged imports, etc., may be used to raise the entrepreneurial rate of return to a level that will induce implementation of the project.

The analyst engaged in a PPA should formulate, in broad terms, the measures required to induce implementation of projects for which the national rate of return indicates a high priority, but for which the enterprise rate of return is too low to attract an investor. The administrative skills and costs, and the general effects of the income transfers (from taxpayers to entrepreneurs) should be considered.

IV. SHAPING THE PROJECT

Decision-making implies the availability of alternative courses of action. If the scarce resources of a nation are to be used in a manner that will make the maximum contribution to growth, project selections must be made only after a wide range of alternatives has been examined. As noted earlier, one of the more valuable functions to be performed in the PPA is the systematic search for the best possible project to meet the objective. The more promising projects must be shaped in a manner to maximize the prospective rate of return.

In the course of the PPA the analyst will think of many possible variations. Consideration in physical terms may be sufficient to indicate some are not feasible, while others may be. In still other alternatives, the analyst must seek to answer the question, "Does the additional investment required by any of the alternatives yield sufficient returns to warrant this additional investment?" Techniques introduced in chapter III and further illustrated in this chapter provide a means of answering questions of this type.

The search for alternatives should cover a wide range in a sector study and a somewhat narrower range in a PPA. While the specific alternatives to be examined will depend on the nature of the objective to be met by the project, the following list suggests several ways in which projects may be shaped, or modified, to enhance their economic and/or financial feasibility:

- Changes in legal or regulatory framework affecting the operations of projects
- Variations in size or scale of projects
- Timing of project implementation

- Modification in technology of production

- Redesign of project to minimize risk by increasing flexibility or adaptability

- Changes in project characteristics designed to reduce real costs arising from damage to the environment.

Modifications Affecting Operations

A checklist of considerations requiring attention in a PPA is presented in appendix C. Although it is not an exhaustive list, it serves to call attention to many factors that could be altered to improve a project.

The checklist will assist the analyst in answering the question, "What kind of change in this specific project might make it better?" In addition to changes, there may be alternatives that are radically different or involve changes that are not physical. For example, alternative solutions may involve:1/

- Changes in regulatory practices and coordination of all elements that would increase the effective capacity of existing or proposed projects

- Rationalization of existing price, rate and tariff structures toward more efficient utilization of existing and projected facilities

- Improvements in administrative and operational efficiency of existing facilities or the proposed project

- Alternative locations of industrial activities to take advantage of more abundant labor supplies, excess capacity in power, transport, education, health or other infrastructure.

1/ Adapted from U.S. Department of Transportation, Economic and Investment Division, Technical Assistance Staff, "Studies for Evaluation of Transportation Capital Projects," mimeographed, Washington, D.C.

Modification of Project Characteristics

Some potentially rewarding types of project modifications are discussed below.

Variations in Size and Scale

The size and scale of projects are quite crucial. A project that is oversized in relation to domestic and export market possibilities will generally have a poor rate of return. The basis for determining the best size and scope is the incremental rate of return on the difference flow of two different-sized projects. The method for applying this test is presented below.

In considering the size of a project, one should be alert to the potential advantages of alternatives that involve earlier or more intensive utilization of facilities. In this connection, the scarcity of capital -- as reflected in the marginal opportunity cost of this resource -- is the critical determinant of the extent to which the scale of the project can be set to anticipate future demands.

In manufacturing, multishift operations of facilities can reduce the investment requirement substantially. In a road project, a low-grade road can be used at the start, with improvements made as the volume of traffic reaches specified levels. The economic advantages of all projects depend in part on other developments, but this is particularly so in the areas of transportation, education, and health.

There is little economic return to a road which carries a low volume of traffic, unless it opens up to development a hitherto unproductive area, and the rate of increase in traffic is rapid. Similarly, school and health projects will not yield their full potential economic benefits unless job opportunities are available for the educated and those with improved health.

Variations in Timing of Projects

Some projects that are not feasible at current and near-term future levels of demand may yield favorable returns at a later time. Thus, if prospective demand rules out the implementation of a project of a size that would permit economies of scale, and the demand is growing, the project may be deferred for later consideration.

Development projects, such as roads, communications and other infrastructure, should be timed so as not to "lead" by an appreciable period of time the other inputs in the development. Interdependent projects, in general, require close coordination lest the unutilized investment sunk in the "lead" projects absorb resources that could have been more productively invested elsewhere.

Similarly, it is important to consider ways of getting output as early as possible. Particularly for large, complex projects, special attention to planning and implementation can make the rates of return more favorable by minimizing delays in completion of construction and run-in time. For example, projects are very sensitive to governmental delays involving licenses, custom clearances, and other government procedures. By calling attention to these factors at an early date, it may be possible to reduce delays quite substantially; necessary legislation or administrative rulings may be obtained in advance. Some design alternatives may permit more favorable phasing (as measured by difference flows). The use of modern scheduling techniques, e.g., PERT, and project controls are effective means of achieving better phasing of inputs and outputs and, thereby, more beneficial projects.

Technology

The choice of technology should be made in light of the relative factor costs in the country in question, availability of technical and managerial skills, and conditions under which the project will be operating. For example, a country that has abundant supplies of labor but is short of capital will find labor-intensive methods of production offer some (but not unlimited) advantages. Each technological alternative will have an associated cash flow; by means of comparisons of the discounted values of the differences in

these flows, the preferred technological alternative can be identified. Each technological alternative will also have other requirements, such as raw materials of specified quality. A frequent mistake in projects is the use of technology which is too advanced, i.e., it places unreasonable demands on available technical and managerial talents. This is a matter that should be addressed explicitly in the project analysis.

Location

Consideration of alternative locations of the project should take into account the effects of respective locations on transport and on access to raw materials and markets as these are reflected in money flows. The effects of the project on increased employment and income in a region in need of development, and the attraction and retention of persons with required skills, also require consideration in the search for higher rates of return. Where the generation of income in a region is preferred for social and political reasons, it is important that the money flows of the best alternative be compared with those likely to be realized in the proposed location of the project.

Standards of Design

In designing a project, the engineer is constantly faced with options that require more capital but give greater durability, lower maintenance cost, less cost of expansion at a later date, or better service. These decisions sometimes come in the form of standards or specifications in the scope of work. Imbedded in the decision is the tradeoff of more capital investment now versus savings or benefits at a later date. Such decisions are best made with regard for the rate of growth of demand, the cost of capital expressed as an annual rate, and the relative costs of the alternative standards.

Flexibility

In the face of uncertainty, it is particularly important to give consideration to alternative project designs that have hedging characteristics, i.e., designs that can

economically accommodate varying circumstances. For example, in designing a manufacturing plant or other facility, one can, at some small increase in investment cost, often make subsequent expansion less costly. In making plans for educational projects, additional modest investments may permit more economical future changes in use of the facility. The building of low-grade roads on good alignments facilitates later upgrading if traffic growth warrants higher standards.

Environmental Considerations

The examination of alternatives cannot be viewed as being complete without explicit consideration of the effects of the project(s) on the environment. For each of the various alternative forms of the project, the environmental effects should be noted, and the economic and financial costs of preventing -- or reducing to tolerable levels -- the undesirable environmental effects should be considered. These costs, in turn, should be compared with estimates of the real economic costs of implementing the project without effective measures to prevent deterioration of the environment.

Many projects may yield attractive rates of return only by excluding real costs in the form of noise, air, or water pollution, soil erosion or loss of aesthetic values. In the PPA, consideration should be given to the shaping of projects in such a way as to minimize the real costs; if the real costs of environmental damage are greater than the real cost of preventive or remedial measures, the NNRR will be increased by modification of the project to incorporate the measures.

However, as the benefits of environmental protection are not likely to yield revenue to the enterprise bearing the costs of the preventive or remedial measures, the BERR is almost certain to be adversely affected. Some form of governmental regulation or subsidy may be necessary to induce enterprises to incur the necessary costs.

Irrigation, manufacturing and power projects are among the more common environmental offenders. Although not necessarily involving capital projects, programs providing chemical fertilizers and insecticides are capable of bringing about profound changes in the ecology of large areas. Power plants may contribute not only to pollution of the

atmosphere, but by thermal pollution of streams, they may also profoundly alter stream ecology.

It is not reasonable to expect that a PPA can anticipate all of the environmental implications of projects, much less place a value on the "costs" of pollution or the "benefits" of prevention or restoration. However, the analyst should at least identify major environmental hazards associated with alternatives, and suggest the nature and extent of additional study required.

Testing for the Preferred Project

The discounting procedure, together with the criteria for project evaluation discussed in chapter III and illustrated in appendix A, provides measures in terms of which the best of a number of alternative formulations of a project can be identified and the degree of its superiority assessed.

An application of the criteria is illustrated in table 1, utilizing the surplus flows from the hypothetical Project A and Project B introduced in chapter III (pp. 30-34).

Project B is accepted as the preferred project in terms of the internal rate of return criterion; the same ranking is arrived at by application of the "discounted value of net benefits" criterion, i.e., the algebraic total of column 6, table 1, is larger than that of column 5. The discounted net difference in surplus flows, shown in column 7, indicates that Project B is superior -- on economic grounds -- to roject A. The comparison of discounted value of net benefits or of the discounted value of the difference in net benefits is the most convenient technique for assessing the relative merits of alternative projects.

The different time patterns in the distribution of the $500,000 surpluses in Projects A and B reflect differences in the assumed circumstances and technologies underlying the two projects. These merit further comment, as they may suggest factors to be considered in the formulation or modification of projects, and in the alternatives that may be examined.

Table 1. Comparative Surplus Flows, Project A and Project B

Year	Undiscounted surplus			Discount rate 12 pct.	Discounted surplus (at 12 pct.)		
	Project A (1)	Project B (2)	Difference: Project B-Project A (3)	(4)	Project A (5)	Project B (6)	Difference: Project B-Project A (7)
1.....	-300	-200	100	.8929	-268	-179	89
2.....	-400	-330	70	.7972	-319	-263	56
3.....	75	75	0	.7118	53	53	0
4.....	80	125	45	.6355	51	79	28
5.....	125	130	5	.5674	71	74	3
6.....	140	130	- 10	.5066	71	66	- 5
7.....	160	130	- 30	.4523	73	59	-14
8.....	190	130	- 60	.4039	77	53	-24
9.....	190	130	- 60	.3606	69	47	-22
10.....	240	180	- 60	.3220	77	58	-19
Total.....	500	500	0		-45	47	92

Source: Chapter III, pp. 31 and 33.

1. Project A is more capital-intensive than Project B in the sense that total investment in the former is $700,000, as compared with only $530,000 in the latter. In Project B, it is assumed that less machinery, or less expensive machinery, is employed than in Project A. In circumstances of abundant labor and high capital costs, this type of factor input adjustment can be made, for example, by using manpower rather than machinery for movement of materials, work in process and finished products with no effect on the quality of product. Other opportunities for substitution also exist, but the range of variation in factor proportions is limited.

2. The size of Project B, that is, the maximum capacity, is more closely related to the size of the immediate market. Hence Project B, with a smaller capacity, will reach capacity sooner (in the third year of its operation) than Project A (in the sixth year of its operation). Thus during the early years of operation the excesses of revenues over current expenditures are greater for Project B than for Project A.

The practical implication of this feature is that projects which may not yield a satisfactory rate of return at an early stage of development may do so at a later stage when the demand for their output has increased because of economic and population growth. Also, projects that are "overbuilt" relative to the size of the market will be less beneficial than those implemented on a more modest scale unless economies of scale are large.

3. It will be noted that the current inputs in years 3 through 10 are higher per unit of output for Project B than for Project A. It is assumed that this reflects the higher variable unit costs arising from the smaller capital investment in Project B. This feature has several important implications for project formulation. First, if demand is unstable, Project B may have an additional advantage because of the greater flexibility in the flow of inputs in years of curtailed demand. Conversely, if demand grows faster than projected, the advantage lies with Project A, as unit costs of inputs fall significantly up to an output approximating its designed capacity.

The "sensitivity analysis," explained in a subsequent section, can be applied in determining the impact of uncertainties with respect to future prices of inputs. Project B, for example, will be very vulnerable to increases in prices of inputs in future years because of the greater importance of current (future) inputs, relative to initial, fixed inputs.

4. Note that there is no positive rate of discount or marginal opportunity cost of capital at which the hypothetical Project A would have a higher present net value than Project B. This is because the undiscounted flows of surpluses have been arbitrarily equated to highlight the importance of timing in project evaluation. However, the priorities accorded to projects may be quite different at different rates of discount (different marginal opportunity costs of capital). In general, the lower the marginal opportunity cost of capital, the higher the more capital-intensive projects or those with longer gestation periods will rank, and vice versa. This is because the lower the rate of discount, the lesser will be the real costs of deferring the benefits from large investments in the gestation period.1/

Other Discounting Applications

The discounting procedure, together with a specified accounting rate of return, provides the central planning authorities with an effective means of securing uniformity of standards in project appraisal, without detailed direction of project analysts. If the shadow price of capital is 15 percent, the project analyst needs only to be told "In considering alternatives, to the extent that there are options with greater or lesser investment or sooner or later investment, choose those options in which the additional capital yields at least 15 percent (assumed shadow price of capital)."

Evaluation of Mutually Exclusive Alternative Investments

The project analyst may be considering two mutually exclusive alternative installations. One requires a larger

1/ The illustrative computations have been made on the assumption that all inputs and outputs take place at the end of the respective years, i.e., in terms of a single payment, present-worth discounting formula. More realistically, a continuous flow discount formula may be used, assuming that outlays for inputs and receipts from output take place evenly throughout each year. The numerical results will differ, but the procedure and interpretation of the results are the same. A continuous flow discount table is provided in appendix D.

investment than the other, but offers lower current costs with greater undiscounted returns over the life of the project (table 2). Is it worth investing $500 more to obtain an additional $850 of output over the life of the project (the undiscounted sum of column 3 of table 2)? Assuming a 15 percent shadow price for capital and applying the discount factors to the difference flow, we find that the present value is negative, indicating that the return on the additional investment is less than 15 percent. The same conclusion can be reached by choosing the alternative with the highest present value. It should be noted that both alternatives have a return in excess of 15 percent as indicated by positive present value. The decision as to which alternative to select should be made on the basis of the return on the marginal investment. (An equivalent decision would be to choose that alternative with the higher present value.)

The type of computation illustrated in table 2 can be used to test a variety of options open to the project analyst such as size, phasing, technology, scope, durability, provision for expansion, location and starting time. This procedure throws the burden of exploring alternatives on the shoulders of those who are in the best position to do so, the project formulators.

The Least-Cost Alternative

Normally, capital projects are appraised in terms of the ratio of benefits to costs, or the difference between costs and benefits, by employing one or more of the criteria described in appendix A. However, there are occasions when, practically, the PPA will be confined to a search for the project which will provide a specified service or other output at the minimum cost.

These situations typically arise where the responsible authorities decide -- on whatever grounds -- that a certain service is to be provided, say, electrification of a rural area, universal education through 6 years, or an access road to a hitherto isolated area. Such decisions are not likely to be influenced by the findings expressed in conventional criteria for project appraisals; however, a comparison of alternative ways of providing the service in order to identify the least-cost alternative is still relevant. The significant least cost is the present discounted value of the

Table 2. Illustrative Computations for Choosing Investment Options Assuming Shadow Price of Capital of 15 Percent

Year	Surplus flow, Project A (1)	Surplus flow, Project B (2)	Difference flow (col. 1 - col. 2) (3)	Continuous flow discount factor 15 percent (4)
1.....	-1,500	-1,000	-500	.9333
2.....	+ 150	+ 200	50	.8115
3.....	+ 250	+ 250	0	.7057
4.....	+ 350	+ 300	50	.6136
5.....	+ 400	+ 300	100	.5336
6.....	+ 450	+ 300	150	.4640
7.....	+ 450	+ 300	150	.4035
8.....	+ 450	+ 300	150	.3508
9.....	+ 450	+ 300	150	.3051
10.....	+ 450	+ 300	150	.2653
Present value of positive values.....	+1,531.3	+1,219.5	352.3	
Present value of negative values.....	-1,400.0	- 933.3	-507.2	
Net present value....	+ 131.3	+ 286.2	-154.9	

alternative streams of inputs. The technique involved is illustrated in table 3, with hypothetical inputs being used for alternative projects to supply school facilities. The more durable building has a higher initial cost, while the less durable building has higher future maintenance costs. Which alternative offers the least costly way of providing the required physical components? As shown in table 3, the choice requires the application of the discounting procedure.

At a continuous flow rate of discount of 12 percent, the less durable building is the least-cost alternative. However, at lower discount rates -- consistent with more abundant supplies of capital -- the more durable building would provide the least-cost alternative. For example, at a continuous flow discount rate of 5 percent the discounted cost difference flow, shown in column 3 of table 3, will have a positive value of approximately 740; i.e., the present value of the costs of the less durable building will be 740 units greater than the present value of the durable building.

Table 3. Investment and Maintenance Costs for Alternative School Buildings

Year	Costs of durable building (1)	Costs of less durable building (2)	Cost difference flow (col. 1 - col. 2) (3)	Continuous flow discount factors 12 pct. (4)
1.....	-5,500	-3,700	-1,800	.9454
2.....	- 500	- 700	+ 200	.8441
3.....	- 500	- 700	+ 200	.7537
4.....	- 500	- 700	+ 200	.6729
5.....	- 600	-1,000	+ 400	.6008
6.....	- 500	- 700	+ 200	.5365
7.....	- 500	- 700	+ 200	.4790
8.....	- 500	- 700	+ 200	.4277
9.....	- 500	- 700	+ 200	.3818
10.....	- 500	-1,000	+ 400	.3409
11.....	- 500	- 700	+ 200	.3044
12.....	- 500	- 700	+ 200	.2818
13.....	- 500	- 700	+ 200	.2427
14.....	- 500	- 700	+ 200	.2167
15.....	- 600	-1,000	+ 400	.1935
16.....	- 500	- 700	+ 200	.1727
17.....	- 500	- 700	+ 200	.1542
Present value of costs at 12 pct..	-8,610	-8,454	- 156	

V. APPRAISAL OF PROJECTS HAVING OUTPUTS DIFFICULT TO VALUE

Many projects produce outputs the valuation of which presents special problems. Some of these projects, such as flood control and to some extent education and public health, yield benefits that are indivisible; other projects yield indirect benefits for which market valuations are not practical. In still other cases, governments may decide as a matter of policy that certain services shall be distributed on a "free" basis, or for only a nominal charge. In all of these cases, the analyst will find it necessary to carry on the appraisal without the benefit of a direct market assessment of the value of output.

There is no completely satisfactory way to place a value on such outputs. However, a number of approaches that have been found to be useful are suggested in the following paragraphs.

Valuation in Terms of Cost of Alternatives

The estimated value of a flood control project, for example, may be based, in part, on the average annual losses incurred from flooding over a representative period of time. To these values might be added such other quantifiable benefits (e.g., prevention of erosion) as might arise from the flood control project.

The value of the output of an educational project to train, say, engineers, may be estimated from the alternate costs of sending students to a foreign country for the required training.

Some types of governmentally provided "free" services may enable individuals to avoid payments made to private suppliers of the same or a similar service. The savings in private expenditure could thus be considered as one component of the value of the government service. The estimated value of the "output" of projects to provide (more adequate) police or fire protection may include the savings in insurance costs, and reductions in private expenditures for fire protection, guards, night watchmen, and protective systems.

Pilot Projects To Determine Value

In some projects, it may be possible to arrive at a reasonably accurate valuation of a service by means of a pilot project -- a sort of experimental testing of the value of a service output. For example, a project to train staff and provide agricultural extension services on a nationwide scale might first be tried out on a small scale under closely controlled conditions that would isolate the increase in output that could be imputed to the extension service. This increase could then be valued in conventional ways, i.e., in terms of prices in domestic or world markets.

While the time and budgetary constraints under which preliminary appraisals are made may preclude the use of the experimental approach, similar bases for valuation may sometimes be developed from statistical analyses of existing data, i.e., by comparisons of outputs in those areas "with" and "without" the services that the proposed project would provide. The value of the output of medical facilities, for example, might be estimated in terms of the differences in incidence of disease and the cost of "lost time" in production attributable thereto in communities with and without such facilities.

Where estimates of the costs and benefits of a proposed project are very much in doubt, the PPA may appropriately recommend a pilot project be undertaken before a final decision on the project is reached.

Estimated Value of Effects on Complementary Activities

Wherever a nonpriced service has important effects on a complementary activity the output of which can be

valued, it may be feasible to measure indirectly what it is not possible to value directly. For example, the "output" of a bridge that permits a substantial reduction in time and distance of travel between points generating and receiving a heavy volume of traffic may be valued in terms of savings in vehicle operating costs made possible by the use of the bridge rather than the longer alternate route. The valuation of most projects for governmental provision of transport facilities will involve estimates based on some measurable benefits to users, usually of a private cost-reduction type.

Valuation of output of educational and public health projects will include the value of additional production attributable to better trained, physically more alert workers and to reduced absenteeism. Additional suggestions for the valuation of outputs of projects of this type are offered in the individual sector guidelines.

If, as will usually be the case, the valuation of outputs of this type of project reflects important subjective judgments, it is well to use a range of values rather than a single value. If, under the regular procedures for computation of an internal rate of return, the project yields a rate equal to or in excess of the accounting rate of interest using the lower limit of the range of value, the project probably merits further consideration.

Minimum Cost and Alternative Levels of Service

Ingenuity will enable the analyst to place a value on many types of outputs not sold for a price. Still, there will be other projects and components of the output of still other projects in which this will not prove to be possible. In these cases, project appraisal takes a more limited form: the search for the least-cost project that will provide specified levels of service.

For example, if the project in question is a hospital, a series of least-cost present values, i.e., discounted inputs, should be provided, with the number of beds, staff-to-patient ratios, types of services provided, etc., identified for each of the least-cost projects. The end results might appear in a form similar to table 4. The various service levels and present values are illustrative only.

Table 4. Alternative Present Value of Inputs at Various Service Levels

Description of services	Number of patients per annum	Present value of inputs (10 yrs.)
Outpatient treatment only. 5 doctors, 8 nurses	30,000	$2,500,000
General Hospital: 8 doctors, 15 nurses; 50 beds	15,000 patient days	
Outpatients:	40,000	5,500,000
General Hospital: 10 doctors, 25 nurses, general surgery, 100 beds	30,000 patient days	
Outpatients:	40,000	15,000,000

Given a "supply (cost) schedule" of the form illustrated, decision-makers will be in a position to arrive at a preferred scale and type of hospital service, taking into account the alternative costs of the service levels provided, competing demands for public funds, and the relative urgency of needs for various publicly provided services.

Valuation of Output and Pricing Policy

There should be no confusion between the task of output valuation, and the question of selling the output for a price. The former should be carried as far as practicable to facilitate an assessment of the project's contribution to the national economy, i.e., to permit computation -- if possible -- of an NNRR. Computation of a BERR for such projects is usually not meaningful. In any case, the process of estimating the value of output is not usually directed to a price determination. However, such estimates may be relevant -- along with other data -- in fixing user charges for facilities provided at governmental expense.

VI. SENSITIVITY ANALYSIS

The NNRR, as described previously, reflects the best estimate of future outputs, prices and other factors that will affect the benefits expected from the project. But uncertainty attaches to these estimates. Therefore, it is necessary that PPA's include an evaluation of the effects of divergence of values from the best estimates of values of inputs and outputs on which rate of return calculations have been based. The purpose is to determine the "sensitivity" of the results of the PPA to prices, levels of demand, etc., differing from the best estimates.

At the preliminary appraisal stage, sensitivity analysis need be undertaken only for major inputs and outputs. The objectives are to:

1. Identify ways in which the project can be modified to minimize risks arising from divergence of realized prices, etc., from best estimates;

2. Identify those areas in which more information is required, and to which special attention should be directed in more detailed analyses of the project, in order to narrow the range of uncertainty;

3. Incorporate the risk factor in the PPA. For example, between two projects with the same national rate of return -- based on best estimates -- the project for which the risk element is smaller should receive priority.

The computed NNRR (or the BERR) on a project is properly regarded as the best estimate -- the mean -- of a range of possible values for the rate. In turn, each of the values for inputs and outputs is likewise a best estimate from a range of values; each value in the range has its "probability" of being realized.

For the major inputs and outputs used in the calculation of the NNRR, three sets of values should ideally be used in the calculation: (1) the best estimate; (2) a lower probable limit; and (3) an upper probable limit. A range of values for the NNRR will emerge when these values for inputs and outputs are used in the calculation of the NNRR.

Sources and Types of Risks

Some risks are controllable, while others are not.

Controllable Risks

Careful project planning and supervision of implementation can reduce or eliminate some risks. For example, early provision for import licenses, construction permits, customs clearance, etc. will be of assistance in avoiding delays in completion of projects; this will lower the probability that construction costs will be at the higher end of the range. A review of projects that have encountered delays and bottlenecks in the past will suggest other causes of unsatisfactory performance or of delay in the completion of construction that can be avoided by planning and/or modification of the project.

Risks may be reduced by providing built-in flexibility in projects: for example, designs to facilitate shifts in output or to permit utilization of substitute fuels and materials. If the availability of managerial and technical skills poses a risk, the project may be redesigned to minimize the requirements for such skills, or to include as project inputs the provision of the required skills from an outside source. From the standpoint of the project -- but not necessarily of the economy -- risks may be shifted by long-term contracts.

A PPA does not require the development of the full range of measures to control risks, but estimates of the administrative and other costs attributable to reduction of risks and uncertainties should be included in inputs for an alternative form of the project; if these additional costs reduce risks sufficiently to raise the expected NNRR, the "preferred project" is that form which includes the risk-reducing outlays.

Uncertainty Resulting From Uncontrollable Factors

The physical resource flow and the money flows of a project will include factors and parameters affecting rates of return of the project that are not subject to control by project design or management. By computing the rates of return under alternative values of these parameters and their respective probabilities, one can determine the probable range of rates of return of the project, and the "best estimate" rate as shown in table 5. The same general procedure can be applied to the values of inputs and outputs.

For example, annual growth rates of demand for electric power and the respective probabilities of their occurrence are estimated as follows:[1/]

Table 5. Computation of "Best Estimate" Rate of Growth in Demand for Electricity

Annual growth (Pct.)		Estimated probability	Growth rates times probability
Range	Mid-point		
5 to 7	6	.20	1.20
7 to 9	8	.40	3.20
9 to 11	10	.30	3.00
11 to 13	12	.10	1.20
Total		1.00	8.60[a/]

a/ "Best estimate" growth rate.

1/ The growth rates in demand for electric power and the respective probabilities would normally be derived from projected rates of growth and changes in structure of GDP.

For an electric generating project, the rate of growth of demand would be sufficiently important to trace the effects of differential rates of growth on the rates of return from specified alternative facilities. In this assessment, the scale of the project should be varied over a range. The (hypothetical) rates of return shown in table 6 are illustrative of the pattern of rates that might emerge from this testing of alternative scales for projects to provide electric power.

As shown in the hypothetical case above, the best estimate of the rate of growth in demand for electric power is 8.6 percent per annum. If the rate of growth in demand is only 6 percent, the preferred project for generation of electric power is the small project; if the rate of growth is 8 percent, the preferred project is the medium-sized one; and if the rate of growth in demand is 10 percent or over, the large-scale project offers the highest prospective rate of return.

The matrix of annual rates of return shown in table 6 would be worked out for each alternative (size) project, at each of the growth rates in demand.

Table 6. Annual Rates of Return for Various Scales of Project at Assumed Demand Growth Rates

	Event (percent demand growth per year)			
	6 pct.	8 pct.	10 pct.	12 pct.
Probability....	.20	.40	.30	.10
	(Annual internal rates of return on project: percent per annum)			
Scale of project:				
Small.....	14	12	10	8
Medium.....	10	15	13	10
Large.....	6	8	14	18

In terms of this hypothetical illustration, the probability of the annual rate of growth in demand being at least 7 percent, but less than 11 percent, is 70 percent; thus, the selection of the medium-scale project is indicated.[1/]

The NNRR on many projects will depend on the overall rate of growth in the economy. Hence, a sensitivity (to GNP growth rate) analysis, similar to the illustration for an electric generating facility, is appropriate for such projects.

Risks Arising From Inadequate Information

At the PPA stage, uncertainties exist because of inadequate information concerning a critical input, or output, value. In such cases it is generally possible to establish a probability distribution of the possible values that may occur.

For example, a probability distribution might be developed in estimating the cost of excavation of a potential site for a dam. The engineer might have visited the site and talked to a geologist who was familiar with the area. On the basis of this limited information his estimates of the possibilities and their respective probabilities might be as follows:

Event	Estimated probability	Estimated cost
Sand	.10	$140,000
Clay	.60	150,000
Rock	.30	300,000

If the cost of excavation connected with the occurrence of rock, together with its probability, is significant, it becomes important to note this and either to undertake

1/ The 70 percent is the sum of the probabilities of 40 percent for a growth rate of 7 percent to 9 percent, and 30 percent for a growth rate of 9 percent to 11 percent per annum.

borings in connection with the PPA analysis, or to warn that such borings need to be undertaken before the decision is made to proceed with the project.

Key Factors to Which Projects Are Sensitive

The key items of sensitivity will vary from project to project. The principal classes that merit the analyst's attention in a PPA are noted in the following paragraphs.

Uncertainty in Demand for Product or Service

The projection of demand for a product or service is, at best, a highly uncertain process. Using whatever historical data are readily available, one makes a projection of demand over time -- a best estimate of the demand.

A useful way of approximating the effects of demands differing from the best estimate is to aggregate those costs that are fixed with respect to volume and those costs that are proportional to the physical volume of output. If x is the percent deviation in volume then:

- Change in value of output for x-percent deviation in volume (constant prices) is given by $\frac{x}{100}$ X (best estimate of total value)

- Change in cost for x-percent deviation in volume is given by $\frac{x}{100}$ X (best estimate of total variable cost)

- Change in surplus flow for x-percent deviation in volume is given by $\frac{x}{100}$ X (total value of output - total variable cost of best estimates)

- After-tax change in surplus for x-percent deviation in volume is given by (1-T) X $\frac{x}{100}$ X (total value - total variable cost) where T is the tax rate.

If the above is computed for the yearly flows, the rate of return corresponding to the percent deviation in volume can be derived readily. Ideally, an upper and lower probable limit of demand calculation should be made.

Uncertainty in Selling Price

Where a product or service is sold, the rate of return (BERR) will be sensitive to the selling price. It is necessary to determine the effects of selling prices that are different from the best estimate.

If the selling price is changed by y percent, then the change in the after-tax surplus for the year is given by $(1-T) \times \left(\frac{y}{100}\right) \times$ (best estimate of total sales revenue).[1/]

However, where an accounting or shadow price is employed in valuation of output, changes in market prices will not necessarily affect the NNRR.

Uncertainty Concerning Cost of Raw Material

Where there is considerable uncertainty about an important variable-cost item such as fuel or raw material, one can readily compute the change in the annual surplus by the relation $(1-T) \times \left(\frac{z}{100}\right) \times$ (best estimate of total variable cost).[2/]

Scope of Sensitivity Analysis

Because there are a large number of factors that can affect the rate of return, the analyst should be selective

1/ Assuming that there is no change in the volume of units sold and that taxes are proportional to revenues. Allowance should be made for price elasticity of demand.
2/ Assuming that the change in price of materials does not influence the volume purchased.

with respect to factors to be tested for sensitivity. The basis for selection should be the degree of uncertainty attaching to major factors and the relative importance of the factor in the determination of the rate of return.

The tecnniques described above can be applied to the BERR as well as to the NNRR analysis. They can also be applied when other criteria, such as the discounted present value of net benefits, are employed in project evaluation. In a PPA, it is suggested that the analyst confine the sensitivity analysis to the NNRR, and to only those inputs and outputs having a critical role in the determination of the rate.

VII. SUGGESTED FORMS FOR COMPILATION OF DATA AND COMPUTATION OF INTERNAL RATES OF RETURN

The principal concepts, estimating procedures and techniques involved in PPA's have been discussed and illustrated in preceding chapters of these guidelines. Suggested forms to facilitate compilation of data and computation of rates of return are presented in this chapter. Hypothetical inputs and outputs are employed to illustrate use of the forms.

Schedule of Domestic Investment

The (hypothetical) numerical values in columns 1 and 2 of table 7 are coefficients to be applied in the pricing of the several inputs; the negative signs preceding these coefficients indicate that they refer to inputs. In a PPA, the numerical values in column 1 would be the ratio of the shadow prices to market prices of the various inputs and outputs.

The column headings "NNRR" and "BERR" refer to the valuation for purposes of computations of the net national rate of return and business enterprise rate of return, respectively. The values entered on the right-hand side of the form represent actual market price valuations (price times quantities) of inputs in each year. In the illustration, all investment is assumed to occur in years 1 through 4, with outputs beginning in the fourth year.

Inputs requiring special treatment in the computation of the rate of return to the national economy include:

Land. In the illustrative case shown in table 7, the correction coefficient for land is unity; i.e., in the illustration, land is priced at its market value in the computation of the NNRR as well as the BERR. Where the market value of land is a relatively small element in total project input, this method of handling the cost of land is satisfactory. However, where a project will require large amounts of productive land, or very valuable land, the NNRR computation should include --as an annual input -- the annual rental value of the land, or an estimate of the annual net product attributable to the land in its alternative use.

Some projects will lead to increased land values (e.g., development roads to open new lands); other projects will depress land values, e.g., a sewage treatment plant in a residential area. In both cases market values will be affected by the project itself -- raised in the first and lowered in the latter case. The "best price," i.e., the cost that measures most accurately the real cost to the economy of the use of the land for the project, is the net loss in output resulting from withdrawal of the land from its preproject use.

Taxes. In general, both internal taxes and customs duties are to be excluded from inputs in computation of the NNRR, but both are included in computing the BERR. The rationale for this exclusion in the former computation is that taxes represent the share of government in the net income generated by the project, and that the total net income (and associated rate of return) are not affected by the way in which the net income is shared by the claimants. However, some payments by enterprises to governments are, in effect, payments for services rendered. Special assessments against real property are sometimes made to reimburse government for the cost of providing water and sewerage service, road access or other infrastructure for the use of the taxpayer. If, in the absence of the governmentally provided service the cost would be an internal charge to the project, it is appropriate to treat the "special assessment" type of levy as a real cost in computing the NNRR.

Similarly, special taxes imposed to finance measures to improve or restore the environment may be charged as a real cost to the project, provided the source of the pollution is clearly identified with the project.

Subsidies. Subsidies are a receipt (or a reduction in cost) in the computation of the BERR; they are assigned a coefficient of zero in computation of the NNRR.

A PPA may be undertaken to determine the amount (and appropriate form) of subsidy required to raise the BERR to a level that would make it "feasible." Hopefully, this investigation will be undertaken only when the NNRR indicates the desirability of the project on economic grounds.

Transfer payment. Transfer payments are, in general, excluded from the NNRR calculation. Taxes, subsidies and borrowing and debt repayment are cases of transfer payments, as distinguished from payments to the owners of factors of production to compensate them for the contribution of the factors to current output.

At the bottom of table 7, the domestic investment inputs are summed by years -- as they will be entered in the computations for the business enterprise and the net national rates of return. The totals for the former are obtained by the simple addition of the amounts shown in each of the annual columns of the value of inputs. No adjustments are necessary since the BERR price-correction coefficients (column 2) are unity (1) for all inputs. This means that market prices are used.

In the case of valuation for purposes of computing the NNRR, market prices are adjusted to conform to shadow or accounting prices. Four adjustments are made in the hypothetical case:

1. The accounting wage rate for unskilled labor is set at 80 percent of the market wage rate (see appendix B).

2. Customs duties paid on imports are not real costs from the viewpoint of the national economy, and hence have a correction coefficient of zero; i.e., they are omitted from the cost of imported components of investment. They would also be omitted from NNRR calculations of imported values of materials, supplies and services used in production.

Table 7. Schedule of Domestic Investments for a Proposed Chemical Plant

Investment	NNRR (1)	BERR (2)	Year 1 (3)	Year 2 (4)	Year 3 (5)	Year 4 (6)
Fixed						
Land	-1.00[a]	-1.00	100			
Labor, skilled, bldg.	-1.00	-1.00	100	500	200	
Labor, unskilled, bldg.	- .80	-1.00	100	400	300	
Other building	-1.00	-1.00	300	2,100	1,000	
Domestic freight	-1.00	-1.00	65	134	140	
Duty on imports	0	-1.00	309	138	665	
Domestic insurance	-1.00	-1.00	32	15	70	
Organization expense	-1.00	-1.00	75	25		
Working capital						
Domestic material inventory	-1.00	-1.00			195	194
Foreign materials duty	0	-1.00			39	
Finished goods inventory	-1.05[b]	-1.00				400
Accounts receivable minus accounts payable	0	-1.00			237	
Cash reserve	0	-1.00			2,000	51
Annual investment from viewpoint of						
Business enterprise (BERR)			-1,081	-3,312	-4,846	-645
National economy (NNRR)			- 752	-3,094	-1,845	-614

a/ See the discussion of alternative treatment of cost of land in NNRR computation.

b/ Coefficient of 1.05 to reflect import content of one-fourth of finished goods inventory [1/4(1.20)+3/4(1.00) = 1.05].

3. Accounts receivable (less accounts payable) are exactly offset elsewhere in the economy by an excess of accounts payable. Hence, this item does not give rise to any net working capital requirement in the economy as a whole. For similar reasons, cash reserves do not constitute a real cost. Zero correction coefficients are used for both categories.

4. The domestic currency is estimated to be overvalued by 20 percent; therefore, for calculation of the NNRR, c.i.f. prices are increased by 20 percent.

The NNRR domestic investment input for year 1 is calculated as follows:

	Actual value (BERR)	Correction coefficient	Real value of input (NNRR)
Land.....	100	1.00	100
Skilled labor (construction).....	100	1.00	100
Unskilled labor (construction).....	100	.80	80
Other construction costs.	300	1.00	300
Domestic freight.....	65	1.00	65
Import duties.....	309	0	0
Domestic insurance.....	32	1.00	32
Organization expense.....	75	1.00	75
Working capital (total)..	0	0	0
Total.....	1,081		752

Computations for other years are made in the same manner. The domestic investment in the finished goods inventory in the fourth year is 5 percent above the market valuation to reflect the overvaluation of 20 percent in the import content (25 percent) of the finished goods inventory.

Schedule of Foreign Exchange Costs

The compilation of data in table 8 follows the same format as that in table 7. In the case used for illustrative purposes, the accounting rate of exchange is 20 percent above the official rate; i.e., the correction coefficient to convert actual to real costs of foreign inputs is 1.20.

As in the case of domestic capital inputs, the correction factors are applied only in the summation of inputs for purposes of NNRR computations. For this purpose, foreign exchange costs of capital inputs in the first year are valued at 3,783.6 (3,153 X 1.2); for the second year, 1,336 X 1.2 = 1,603.2 etc.

The adjustment in the c.i.f. prices of imported capital goods for overvaluation of the domestic currency is comparatively straightforward, given the estimate of a correct shadow price for foreign exchange. In principle, the value of domestic inputs (capital or operating) should be adjusted also to include a shadow price of the import content of inputs purchased or priced domestically. This has been done in the case of the finished goods inventory, shown in table 7. It might also be appropriate to make a similar adjustment in domestic freight expenses to reflect the undervaluation of the import content of the investment in railways, highways and road transport, as well as the import content of current inputs of fuel and supplies. Similar adjustments should be made for raw materials produced with imported machinery, equipment, fuel and power, and various intermediate goods produced with foreign inputs.

Obviously, such adjustments can be extended in principle to most domestic inputs. However, in all but the most exceptional cases, it is suggested that the adjustments for overvaluation of the domestic currency be confined to the <u>direct imports</u> for the project in a PPA. The exceptional cases might include adjustment for the import content of electric power used by a projected bauxite smelter, or domestically refined POL products from imported crude in appraising transport projects. In both cases, the import content is a significant component of the cost of the domestic input, and the particular inputs are, in turn, significant components of the total project inputs.

Alternatively, a general adjustment might be made for broad categories of projects, based on average import content of inputs in the sectors in which the projects are found.

The separation of investment inputs into two categories, domestic and foreign (tables 7 and 8, respectively), is advisable. Separate projections of foreign exchange requirements will facilitate consideration of financing, scheduling of debt service requirements and other matters involving balance of payments.

Projected Operating Statement

The operating statement shown in table 9 corresponds -- in a general way -- to the conventional profit and loss statement. It will be noted that the statement shown in table 9 begins with year 4; this assumes 3 years will be required for construction during which there will be no output.

The NNRR and BERR symbols and the correction coefficients have the same meanings as in tables 7 and 8. Several of the individual items in table 9 merit explanatory comment.

Depreciation. While conventional profit and loss statements (properly) recognize depreciation as a cost and profit as a residual, neither item is recognized explicitly in the computation of either the BERR or NNRR. The total cost of assets is entered as an input in the year in which acquired; to record depreciation as an additional cost (input) would involve double counting.

Wage and salary payments to foreign personnel. It is assumed that one-half of the salary is paid in foreign, and one-half in domestic, currency. Thus, the correction coefficient applied in the calculation of the NNRR is $\frac{1.20+1.00}{2} =$ 1.10. For calculation of the BERR, such payments are entered at market rates.

Unskilled labor. The correction coefficient is 0.80, for the same reasons explained in connection with table 7.

Table 8. Schedule of Foreign Exchange Costs of a Proposed Chemical Plant

Investment	NNRR	BERR	Year 1	Year 2	Year 3
Fixed					
Equipment.....	-1.20	-1.00	3,088	1,307	6,665
Foreign freight..	-1.20	-1.00	65	29	140
Engineering.....	-1.20	-1.00			1,145
Working capital					
Foreign materials for inventory...	-1.20	-1.00			182
Foreign exchange component of investment					
Business enterprise (BERR)....			-3,153	1,336	-8,132
National economy (NNRR).....			-3,783.6	-1,603.2	-9,758.4

Table 9. Projected Operating Statement, Proposed Chemical Plant

Investment	NNRR	BERR	Year 4	5	6	7	8	9	10	11	12	13	14	15
Foreign personnel[a/].....	1.10	-1.00	58	72	36	18	0	0	0	0	0	0	0	0
Personnel, skilled.....	-1.00	-1.00	414	532	532	532	532	532	532	532	532	532	532	532
Personnel, unskilled.....	- .80	-1.00	100	100	100	100	100	100	100	100	100	100	100	100
Payroll taxes.....	0	-1.00	89	110	110	110	110	110	110	110	110	110	110	110
Dom. raw materials & supplies..	-1.00	-1.00	1,396	1,854	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040	2,040
For. raw materials & supplies..	-1.20	-1.00	185	220	246	246	246	246	246	246	246	246	246	246
Duty.....	0	-1.00	16	22	25	25	25	25	25	25	25	25	25	25
Electricity.....	-1.00	-1.00	256	372	408	408	408	408	408	408	408	408	408	408
Insurance.....	-1.00	-1.00	60	60	60	60	60	60	60	60	60	0	60	60
Depreciation.....	0	0	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Misc. domestic supp. & services.	-1.00	-1.00	542	628	662	662	662	662	662	662	662	662	662	662
Subtotal of cost.			4,446	5,300	5,549	5,531	5,513	5,513	5,513	5,513	5,513	5,513	5,513	5,513
Sales.....	+1.00	+1.00	8,833	10,292	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805	12,805
Profit before taxes.....	0	0	4,387	4,992	7,256	7,274	7,292	7,292	7,292	7,292	7,292	7,292	7,292	7,292
Operating surpluses, viewpoint of:														
Business enterprise (BERR)			5,717	6,322	8,586	8,604	8,622	8,622	8,622	8,622	8,622	8,622	8,622	8,622
National economy (NNRR)			5,799	6,423	8,688	8,708	8,728	8,728	8,728	8,728	8,728	8,728	8,728	8,728

a/ Half assumed to be paid in foreign currency.

Imported raw materials. The correction coefficient is 1.20, the same as in table 8, to reflect overvaluation of domestic currency.

Derivation of Net Operating Surplus

The annual net operating surpluses will differ, depending on whether the concept refers to the business enterprise, or the national economy.

Business enterprise annual surpluses. The BE surplus is the revenue from sales, less total costs, exclusive of depreciation. For year 4, the computed surplus is 8,833 - (4,446-1,330) = 5,717; for year 5, it is 10,292 - (5,300-1,330) = 6,322, and so on for subsequent years.

National economy annual surpluses. Computation of the annual surpluses, viewed from the standpoint of the national economy, requires the application of other correction coefficients. For year 4, the actual costs, correction coefficients, and national economic costs are as follows:

	Actual costs (BERR)	Correction coefficients	National economic (real) costs (NNRR)
Foreign personnel.....	58	1.10	64
Skilled workers.....	414	1.00	414
Unskilled workers.....	100	.80	80
Taxes, payroll.....	89	0	0
Domestic materials and supplies.....	1,396	1.00	1,396
Foreign materials and supplies.....	185	1.20	222
Import duties.....	16	0	0
Electricity.....	256	1.00	256
Insurance.....	60	1.00	60
Miscellaneous, domestic.....	542	1.00	542
Total costs.....	3,116		3,034

Initially, the market value of output is assumed to reflect the real value to the economy. In year 4, this value is 8,833; thus, from the viewpoint of the national economy, the surplus flow for year 4 is 8,833 - 3,034 = 5,799.

For subsequent years, the BERR and NNRR surpluses have been computed in the same manner shown in table 9.

Summation and Computation of NNRR

The values of inputs and outputs derived in tables 7 and 9 are brought together, and the computation of the internal rate of return to the national economy is demonstrated, in table 10. The various sources of table 10 are explained below, column by column.

Column 1. From table 7.

Column 2. Column 2, from table 7.

Column 3. From table 9.

Column 4. Columns 1 plus 2 plus 3.

Column 5. This column shows new information: the amount by which the market prices used in valuation of output overstate the valuation in terms of c.i.f. plus handling, which is taken as the real value of output. The amounts are subtracted from column 4 to yield a more refined valuation of the flow of surpluses accruing to the national economy by shadow pricing output.

Column 6. Column 4 minus column 5.

Column 7. From the table of continuous flow discount factors in appendix D.

Column 8. Column 6 multiplied by column 7, by years.

Column 9. From the table of continuous flow discount factors in appendix D.

Column 10. Column 8 multiplied by column 9, by years.

Computation of the NNRR by interpolation is shown at the bottom of table 10.

Table 10. Summation and Computation of NNRR

Year	Domestic investment (1)	Foreign exchange investment (2)	Operating surplus (3)	Total unadjusted surplus flow (4)	Adjustments for price and other factors (5)	Adjusted surplus flow (6)	Discount factor at 20% (7)	Discounted surplus flow at 20% (8)	Discount factor at 25% (9)	Discounted surplus flow at 25% (10)
1	-652	-3,784	0	-4,436		-4,436	.9141	-4,055	.8963	-3,976
2	-3,094	-1,603	0	-4,697		-4,697	.7618	-3,578	.7170	-3,368
3	-1,845	-9,758	0	-11,603		-11,603	.6348	-7,366	.5736	-6,655
4	-594		5,799	5,205	-810	4,395	.5290	2,327	.4589	2,019
5			6,423	6,423	-1,039	5,484	.4408	2,417	.3671	2,013
6			8,688	8,688	-1,253	7,435	.3674	2,732	.2937	2,184
7			8,708	8,708	-1,253	7,455	.3061	2,282	.2350	1,752
8			8,728	8,728	-1,253	7,475	.2551	1,907	.1880	1,405
9			8,728	8,728	-1,253	7,475	.2126	1,589	.1504	1,124
10			8,728	8,728	-1,253	7,475	.1772	1,325	.1203	899
11			8,728	8,728	-1,253	7,475	.1476	1,103	.0962	719
12			8,728	8,728	-1,253	7,475	.1230	919	.0770	576
13			8,728	8,728	-1,253	7,475	.1025	766	.0616	460
14			8,728	8,728	-1,253	7,475	.0854	638	.0493	369
15			8,728	8,728	-1,253	7,475	.0712	532	.0394	295
16			689	689	-105	584	.0593	35	.0315	18
Present value of discounted surplus flows:								3,573		-166

Internal rate of return to National Economy by interpolation:

$$NNRR = 20\% + \frac{(3,573)}{(3,573+166)} \times 5\%$$

$$= 20\% + (.956) \times 5\%$$

$$= 20\% + 4.8\% \quad = 24.8\%$$

Net Rate of Return to the Business Enterprise

Computation of the net (internal) rate of return to the business enterprise is made in the same manner as for the national economy, except for adjustments shown in column 5 of table 8 which are not applicable in the case of the BERR.

The BERR, as computed from the illustrative case, is approximately 27.6 percent. It is higher than the internal rate of return for the national economy as a whole because: (1) a shadow price is used for inputs requiring foreign exchange; i.e., a higher value has been placed on imported inputs in the NNRR than in the BERR calculation; and (2) a shadow price (c.i.f. plus handling cost) is used for valuation of output in computing the NNRR but not the BERR. As the estimated domestic price of output is higher than the c.i.f. price, this adjustment contributes to the lower rate for the NNRR.

While the relationship will vary from country to country, as well as from project to project, the NNRR will commonly be higher than the BERR because:

1. Taxes and customs duties are excluded from inputs in computing the NNRR, but not the BERR

2. The shadow price for unskilled labor is usually below market wage rates.

An Evaluation Summary

The results of the PPA should be presented in a comprehensive report, but with a summary employing the minimum of technical terms. That is, the summary should be designed to provide decision-makers with an easily understood statement of alternatives and recommendations. The form of the full report may be dictated by the requirements of the sponsoring agency.

APPENDIX A: CRITERIA FOR PROJECT APPRAISAL

Estimated values of annual inputs (costs) and outputs (benefits) of projects must be aggregated in a manner that will permit comparisons among projects. There has to be a standard established for the economy as a whole. Then those projects which offer a greater excess of discounted outputs (benefits) over inputs (costs) can be assigned a higher priority than those from which lesser net returns are expected. Since projects vary in absolute size and in the timing of inputs and outputs, a measure, or criterion, must be applied that will enable the analyst and/or decision-makers to rank projects in terms of a common denominator.

Three criteria are widely used as measures in terms of which the comparisons noted above are made:

1. Discounted benefit-cost ratios
2. Internal rates of return
3. Discounted present values of net benefits.

Each of these measures has certain advantages -- and limitations. These are briefly described below.

The Discounted Benefit-Cost Ratio

The discounted benefit-cost criterion has been widely used in project appraisals but it yields results which can be misleading. For this reason, caution should be exercised in the application of this method of ranking projects. In general, the discounted B/C ratio is a less reliable criterion than the internal rate of return and discounted present value of net benefits criteria.

The following is suggested as an appropriate format for an evaluation summary:

I. Technical Feasibility

A. Description of best alternative project in terms of location, size, construction and production processes (technology) and designed capacity

B. Explanation of unresolved technical issues; recommendations for further engineering investigations

C. Compatibility of technical characteristics and

1. Managerial capabilities
2. Labor force
3. Climatic conditions
4. Environmental standards
5. Availability of machinery and equipment, operating supplies, power and transport

II. Economic Feasibility

A. Demand and/or output projections

B. Estimated inputs

1. Capital
   a. Foreign
   b. Domestic

2. Operating
   a. Foreign
   b. Domestic

C. Pricing assumptions

1. Output
   a. Market prices
   b. Shadow prices, if used

2. Inputs
   a. Market prices
   b. Shadow prices, how estimated
      (1) Unskilled labor
      (2) Marginal opportunity cost of capital
      (3) Foreign exchange rate
      (4) Other, if used

D. The net national rate of return (NNRR)

1. The preferred alternative form of the project

2. Alternatives used in comparison, and characteristics

E. Sensitivity Analysis

1. Range of probable NNRR

2. Proposed measures to reduce risks and raise NNRR

3. Recommendations for further study, if necessary

III. <u>Enterprise Feasibility</u>

A. The business enterprise rate of return (BERR)

1. The preferred alternative form of the project

2. Alternatives, for comparison

B. Proposed measures to effect reconciliation of BERR and NNRR, if required

IV. Other Considerations in Project Selection

A. Consistency with development strategy and policy objectives:

1. Distributive effects
2. Regional pattern of development
3. Import substitution versus export promotion
4. Employment effects
5. Effects on interindustry linkages, i.e., industrial integration

B. Environmental effects

V. Recommendations

A. Rejection of project

B. Postponement of project

C. Modification and further study

D. Full feasibility study

1. Identification of those aspects, concerning which available data do not provide basis for firm finding
2. Suggested scope of work for feasibility study

E. Design and finance

1. Qualifications
2. Recommended measures to enhance project
   a. Government policies, practices and administration
   b. Training
   c. Supporting projects

One of the limitations arises from the degree of "grossness" -- or netting out of costs and benefits -- employed in the appraisal. The effects of netting out of current operating costs from both the inputs and outputs are shown in table A-1.

Although the hypothetical case presented in table A-1 covers only a short span of years, the discounted B/C ratio is raised by computing it on the net rather than the gross basis. If the B/C ratio is greater than unity on the gross basis, it will always be raised by the netting out process illustrated in table A-1; conversely, if the ratio is less than unity on a gross basis, the netting out will always reduce the ratio.

Thus, the size of the discounted B/C ratio for projects will depend, in part, on the degree to which netting out of items is applied. In practice, some analysts may net out more (or less) than others, depending in part on their data problem. What is perhaps of greater importance, different industries (and even different projects in the same industry) may have widely varying ratios of current operating costs to total inputs. For the latter reason, discounted B/C ratios do not provide a sound basis for selection of projects that will make the maximum contribution to economic growth, i.e., projects selected on the basis of this criterion will not necessarily yield the largest increases in discounted present values.[1/]

Benefit-cost ratios, as a criterion for project evaluation, are sensitive to the discounting rate employed in a way in which the internal rate of return is not. In the final analysis, the internal rate of return is a computed rate; the value of the B/C ratio depends, in part, on the rate of discount selected for the exercise. As a practical matter, in computing B/C ratios there is a tendency to use the rate at which funds can be obtained to finance a project as the discount rate. This may well be different for different projects (thus precluding meaningful inter-project comparisons in terms of discounted B/C ratios); and

1/ For an elaboration of the inherent limitations of this criterion see Roland N. McKean, Efficiency in Government Through Systems Analysis, pp. 107-113.

Table A-1. Effects of Netting Out of Current Operating Expenses on Benefit-Cost Ratios

I. In Gross Terms

Year	Total inputs	Current cost inputs	Total outputs	Discounted 10 pct.		
				Total inputs	Total outputs	Surplus flow
1.....	200	(0)	0	182	0	-182
2.....	300	(25)	100	248	83	-165
3.....	50	(40)	200	38	150	112
4.....	100	(60)	300	68	205	137
5.....	200	(100)	450	124	279	155
Total.	850		1,050	660	717	57

Ratio of Gross Benefits to Gross Costs, both discounted at 10 percent = $\frac{717}{660} = 1.086$

II. In Net Terms (benefits and costs reduced by current operating costs)

Year	Net inputs	Net outputs	Discounted 10 pct.		
			Net inputs	Net outputs	Surplus flow
1.....	200	0	182	0	-182
2.....	275	75	227	62	-165
3.....	10	160	8	120	112
4.....	40	240	27	164	137
5.....	100	350	62	217	155
Totals.....	625	825	506	563	57

Ratio of Net Benefits to Net Costs, both discounted at 10 percent = $\frac{563}{506} = 1.11$

these rates may be below or above the marginal opportunity cost of capital (thus precluding meaningful evaluation of projects in terms of their potential contribution to national economic growth).

Internal Rate of Return

The internal rate of return criterion recommended in these guidelines is not subject to these limitations. As shown in the last column of parts I and II of table A-1, the "surplus flow" (one basis for computation of the internal rate of return) is independent of the degree of netting out, i.e., it is the same whether inputs and outputs are on a gross or net basis. As the internal rate of return is equal to the rate of discount that will reduce the algebraic total of the discounted annual surpluses (deficits) to zero -- or equate the discounted annual inputs and outputs -- it will be the same (for any given project) whether gross or net values are used.

It is also unnecessary to estimate, or select, in advance a discount rate in using the internal rate of return criterion; the rate of return on the project is derived from the undiscounted values of inputs and outputs, or the stream of surpluses and deficits. When internal rates of return have been computed for a number of projects, the projects can be ranked on the basis of the computed rates. However, at this stage, the computed rates should be compared with the best estimate of the marginal opportunity cost of capital. On purely economic grounds, only those projects with internal rates of return equal to or above the estimated marginal opportunity cost of capital would be selected for more detailed feasibility studies and/or implementation.

The internal rate of return criterion is also subject to limitations. In the first place, it embodies the implicit assumption that the stream of surpluses yielded by the project can be reinvested at the computed internal rate of return on the project. To the extent that this assumption is not realized, the actual rate will diverge from the computed rate, even if all estimated costs and benefits are realized.

A second limitation of this criterion is that it may yield indeterminate results; i.e., there may be no discount rate, or two discount rates that will equate costs and benefits. Two rates will result when the stream of differences between costs and benefits changes from negative to positive values, and subsequently becomes negative.

Although it is not a serious limitation in practice, the internal rate of return calculation yields only a single, unvarying rate of return over the life of the project -- if the computation yields a determinate rate.

Discounted Present Value of Net Benefits

Conceptually, this criterion is subject to fewer limitations as a guide to project evaluation than either of the two criteria discussed above. It does require, however, the use of a predetermined discount rate reflecting the marginal opportunity cost of capital. This rate may be varied over the life of the project, a procedure which may be desirable in certain circumstances.

Given estimates of the value of inputs and outputs over the life of the project, the discounted present value of net benefits is derived by applying the appropriate discount factor to the difference between the value of output and input for each year, and adding (algebraically) the discounted values. The sum is the "discounted present value of net benefits." If this value is positive the project merits further consideration -- assuming the discount rate has been correctly selected, i.e., that it reflects the marginal opportunity cost of capital. As the computed discounted present value of net benefits approaches zero, the internal rate of return on the project approaches the rate used in discounting.

The discounting of net benefits, i.e., the value of annual outputs minus the value of annual inputs, is especially useful in evaluating alternative projects. In this application, the stream of surpluses (deficits) for each of the alternatives is first computed; then a third stream of annual surpluses (deficits) is found as the difference between the annual surpluses (deficits) of the alternative projects. The stream of annual differences is

then discounted; if the sum of the discounted annual differences is positive (assuming the discount rate is an accurate reflection of the marginal opportunity cost of capital), the preferred alternative is the project with the larger (positive) stream of surpluses.

Comparison of Computations

A comparison of steps in computation of the three criteria is presented below, with reference to hypothetical data shown in tables A-2 and A-3.

The assumed values of inputs and outputs are shown in columns 1 and 2, respectively, of table A-2; the stream of annual net benefits (undiscounted) is shown in column 3 and is obtained by subtracting column 1 from column 2. Discount rates at 8 percent per annum and 15 percent per annum (from table D-1, appendix D) are shown in columns 4 and 5. The discount rates are equal to $\frac{1}{(1+r)^n}$, where r is the rate assumed, the marginal opportunity cost of capital, and n is the number of years.

The annual values of inputs and outputs shown in columns 1 and 2 are multiplied by the discount factors in column 4 to obtain discounted present values of inputs and outputs (at 8 percent), shown in columns 6 and 7. (Column 8 is not required for the discounted benefit-cost ratio computation.)

The discounted benefit-cost ratio is obtained by dividing the algebraic sum of column 7 by the algebraic sum of column 6. In the example, a ratio of 1.08 is obtained, with a discount rate of 8 percent.

The annual values of inputs and outputs (and the resulting surpluses and deficits) discounted at an annual rate of 15 percent are shown in columns 9, 10 and 11, respectively. At a 15-percent rate, the discounted benefit-cost ratio is .98, i.e., less than unity.

Table A-2. Computation of Discounted Benefit-Cost Ratios and Present Values of Net Benefits

Year	Value of			Discount factors		Discounted values: 8%			Discounted values: 15%		
	Inputs (1)	Outputs (2)	Surplus[a/] (3)	8 pct. per year (4)	15 pct. per year (5)	Inputs (6)	Outputs (7)	Surplus[a/] (8)	Inputs (9)	Outputs (10)	Surplus[a/] (11)
1....	10,000	0	-10,000	.9259	.8696	9,259	0	-9,259	8,696	0	-8,696
2....	5,000	3,000	- 2,000	.8573	.7561	4,287	2,572	-1,715	3,781	2,268	-1,512
3....	5,000	7,000	2,000	.7938	.6575	3,969	5,557	1,588	3,288	4,603	1,315
4....	5,000	8,000	3,000	.7350	.5718	3,675	5,880	2,205	2,859	4,574	1,715
5....	5,000	8,000	3,000	.6806	.4972	3,403	5,445	2,042	2,486	3,978	1,492
6....	5,000	8,000	3,000	.6302	.4323	3,151	5,042	1,891	2,162	3,458	1,297
7....	5,000	8,000	3,000	.5835	.3759	2,918	4,668	1,751	1,880	3,007	1,128
8....	5,000	8,000	3,000	.5043	.3269	2,522	4,034	1,513	1,635	2,615	981
9....	5,000	8,000	3,000	.5002	.2843	2,501	4,002	1,501	1,422	2,274	853
10....	5,000	8,000	3,000	.4632	.2472	2,316	3,706	1,390	1,236	1,978	742
Total.	55,000	66,000	11,000			38,001	40,906	2,907	29,445	28,755	-685

Discounted benefit-cost ratio (8%) = $\frac{40,906}{38,001} = 1.08$

Discounted benefit-cost ratio (15%) = $\frac{28,755}{29,445} = .98$

a/ Minus (-) figure indicates deficit.

Table A-3. Interpolating for Internal Rate of Return

Year	Undiscounted net benefits[a/]	Discounted at	
		13 pct. per year	14 pct. per year
1.....	-10,000	-8,850	-8,770
2.....	- 2,000	-1,556	-1,538
3.....	2,000	1,386	1,350
4.....	3,000	1,839	1,776
5.....	3,000	1,629	1,557
6.....	3,000	1,440	1,368
7.....	3,000	1,275	1,200
8.....	3,000	1,128	1,053
9.....	3,000	999	924
10.....	3,000	885	810
Discounted present value.....		65	-270

Internal Rate of Return, by interpolation:

$$IRR = .13 + .01\left(\frac{65}{65+270}\right)$$

$$= .13 + .0019$$

$$= 13.2\%$$

a/ From table A-2.

Similar computations for a number of projects would provide a basis for ranking; no project on which the discounted benefit-cost ratio is substantially less than 1.0 would normally be considered acceptable for more detailed project studies, or for implementation on the basis of purely economic considerations. A ratio value of less than unity indicates an internal rate of return below the marginal opportunity cost of capital.

The computation of the discounted present value of net benefits is also illustrated in table A-2. As shown in column 8, the present value of the algebraic sum of the annual benefits (deficits), discounted at 8 percent per annum, is 2,907 -- indicating this to be an acceptable project if the marginal opportunity cost of capital is 8 percent per annum or less. However, at a 15-percent discount rate, the project does not yield a rate of return equal to that available from other projects, i.e., equal to the marginal opportunity cost of capital. The observed results may be generalized; if the discounted present value of net benefits is positive (assuming the rate of discount is equal to the marginal opportunity cost of capital), the project is worthy of further feasibility study or of whatever step toward implementation is appropriate. Projects may be ranked or assigned priorities in terms of the absolute value of the discounted present values of their respective net benefits.

The direct computation of internal rates of return on projects is cumbersome; a satisfactory approximation can be obtained by interpolation from discount rates. The procedure is illustrated in table A-3, with the basic input and output data drawn from table A-2.

The internal rate of return may be defined as a discounted rate that will equate the stream of values of inputs and outputs, or -- alternatively -- the rate of discount required to reduce the present value of the stream of net benefits to zero.

It can be seen that the internal rate of return is substantially above 8 percent per annum (as shown in column 8, table A-2, at 8 percent the discounted present value of the stream of net benefits is 2,907). It can also be seen that the internal rate of return is below 15 percent per annum (as shown in column 1, table A-2). At a 15 percent

rate of discount the discounted present value of the stream of surpluses is negative, -685. Hence the rate that will equate the present value of inputs and outputs (given a zero discounted present value of net benefits) is greater than 8 percent but less than 15 percent.

The internal rate of return can now be approximated by a (usually short) process of selecting a rate on either side of the anticipated solution and interpolating. This procedure is illustrated in table A-3.

The approximate internal rate of return can be interpolated as follows:

$$\text{IRR} = .13 + .01 \left(\frac{65}{(65 + 270)} \right) = .13 + .0019$$

$$= 13.2 \text{ percent per annum.}$$

APPENDIX B. PRICING IN PROJECT APPRAISALS

The "pricing" of physical units of inputs and outputs is a crucial step in project appraisal. The use of inappropriate, or inaccurate, prices in the valuation of inputs and outputs will give rise to misleading measures of the economic benefits of proposed projects.

In appraising projects from the standpoint of their contribution to national economic growth, the "appropriate" set of prices is that which reflects real costs (of inputs) and real benefits (of outputs) to the economy. These real costs and benefits may or may not be accurately measured by market prices. This appendix offers suggestions for identification of those instances in which market prices are likely to be unacceptable measures of real costs or benefits, and for the estimation of accounting or shadow prices to use in place of market prices. While certain market prices are often wide of the mark as measures of real costs and benefits, market prices are likely to be reasonably accurate measures of the type required for national economy appraisals. In any case, most estimates of shadow or accounting prices have, as their point of departure, actual market prices.

In the evaluation of projects from the standpoint of the enterprise, whether privately or publicly owned, the appropriate prices are market prices. Price questions have to do with:

- Current versus projected future prices
- What to do about inflationary price trends
- The averaging of prices to minimize distortions
- What price to use when the output of the project exerts a strong influence on market price.

These and related aspects of pricing are discussed in this appendix.

Price Projections

Whether market prices, or substitutes for them, are employed in pricing inputs and outputs, in principle, the relevant prices are those expected to prevail during the course of the life of the projects.

If relevant price projections are available from the central planning authority, the central bank or other reliable sources, these may be used in a PPA. However, in a PPA, the development of price projections is likely to require more time and effort than can be devoted to the task. As an alternative both inputs and outputs may be priced at constant average prices for recent years, with perhaps some adjustments where such prices are clearly atypical. If this is done, the sensitivity analysis discussed in chapter VI should include an appraisal of probable price changes and their effects on the respective rates of return on the several projects.

In the case of large projects that can be expected to produce significant effects on either the prices of inputs or outputs, an effort should be made to anticipate such price changes in estimating future costs and benefits. For example a large-scale grazing scheme that will, say, triple the domestic supply of meat and dairy products will probably exert a downward pressure on prices that should be taken into account in estimating the value of future output. If the same project will create a demand for, say, twice the presently available domestic supplies of oil cake, the probable effects on costs should also be taken into account.

Market Prices

In computing the business enterprise rate of return (BERR), the appropriate prices for estimating the values of inputs and outputs are market prices. In LDC's markets are frequently fragmented and unit prices may therefore show considerable variation from place to place. Also, prices may fluctuate sharply in the short run as a result of seasonal shortages (gluts) in supply, interruptions in transport, or

hoarding and variations in the severity of import restrictions. Therefore, in the application of market prices in a PPA, some averaging may be advisable to minimize distortions that may otherwise arise from short-run fluctuations and from imperfections in markets.

Accounting or Shadow Prices

In computing the net national rate of return (NNRR), consideration must be given to the use of accounting or shadow prices in lieu of market prices in the valuation of inputs and outputs. The decision to use these prices, however, is not one to be taken lightly. Quite clearly the prices used will have an important effect on the end results of the PPA, and the estimation of an appropriate accounting or shadow price is by no means a simple task. Shadow pricing should be undertaken only when market prices of significant inputs or outputs are clearly inaccurate measures of real economic costs of inputs, or of the "real" value (benefits) of output. The real economic cost of a factor of production is the marginal opportunity cost, i.e., the loss in output in the present marginal use of an input that would result if the marginal unit of the factor of production were transfered to the project.

Real costs play a critical role in project evaluation. Yet, when projects are being appraised, there is no completely satisfactory, operationally feasible method for estimating the real, that is, the shadow, or accounting prices. Given technological conditions of production and patterns of behavior of producers and consumers, there exists a unique "optimal" pattern of resource allocation, and a related unique structure of equilibrium prices associated therewith. Such prices are opportunity costs, and are the appropriate ones to employ as shadow prices in project appraisals designed to attain optimum resource utilization under the given conditions.

As a practical matter, however, the derivation of an equilibrium set of interdependent shadow or accounting prices based on economic models is not likely to be feasible in LDC's or in most developed countries, for that matter. Therefore, where accounting or shadow pricing is deemed to be necessary, a process of estimating shadow or accounting prices from market prices is generally employed. However, the ad hoc estimation of shadow prices presents certain problems. The

concept of an appropriate shadow price is that of an equilibrium price, the value of which depends on all other prices. Thus, the use of shadow prices for some inputs and outputs, but not for others, can give rise to distortions in project evaluation as serious as those the shadow pricing is designed to avoid.

Despite the shortcomings of shadow prices derived by partial, ad hoc procedures -- the only ones likely to be feasible -- imperfect shadow pricing is probably preferable to exclusive reliance on market prices where the latter are clearly inaccurate measures of real costs and benefits, and where projects are being evaluated in terms of their potential contribution to national economic growth.

The market prices most frequently found to be unsuitable for use in estimation of the NNRR (as distinguished from the profitability of the project from the enterprise point of view) are

1. Interest rates, as the cost of capital

2. The wage rate of unskilled labor, particularly in LDC's with high rates of unemployment and extensive underemployment;

3. The official rate of exchange between the domestic currency and hard currencies.

In some situations, the project analyst may find that shadow prices for major inputs (unskilled labor, capital, foreign exchange) have been estimated by a central planning authority. If available, these estimates should be used unless they are patently wide of the mark. The use of these established accounting or shadow prices will conserve the time of the project analyst; more important, if such prices are used in all project appraisals a higher degree of comparability will be achieved than would be the case if each analyst attempted to establish his own set of shadow prices.

While shadow prices should be adjusted periodically to reflect changes in the economy, the same unit prices (market or shadow) should be used for all projects being

evaluated at any given point in time in order to avoid distortions in computed rates of return on projects.

In the absence of satisfactory ready-made estimates of shadow prices, the analyst should make such estimates for major inputs and, where relevant, outputs. Some approaches to these estimations are suggested below.

Accounting Prices for Capital

The marginal opportunity cost of capital may be viewed as the loss in output to the economy that would be entailed by withdrawal from production of the marginal increment of capital invested. The concept, as used in the criteria employed in a PPA, implies that a project "passes" only if it promises to yield a rate of return equal to or greater than the return that would be earned by the required capital in an alternative marginal investment. Conceptually, the marginal opportunity cost of capital is an equilibrium rate that will equate the demand for funds and the available supply. The fact that funds are available for a particular project at a lower or higher rate of interest than the accounting or shadow rate is not relevant in project appraisals to determine the merits of the project in terms of its potential rate of return to the national economy (NNRR).

The marginal opportunity cost of capital is not readily apparent from market prices, i.e., interest rates. At any given time, the market for capital will exhibit not one interest rate but a wide range of such rates. The rates differ because of differences in several types of risks, maturity of loans, tax treatment of interest incomes, government regulations and policies toward preferred borrowers, administrative costs and general imperfections in capital markets. All of these rates include the real cost of capital, but also most will contain elements (positive and negative) that are not properly included in the shadow price of capital. The essential task in the estimation of the shadow cost of capital is to isolate the rate that would be necessary to equate the supply of and demand for riskless loans over a period of time equivalent to the life of the project being appraised.

Under certain circumstances (a stable government and a free market in central government securities) the yield to maturity of long-term government bonds is probably the best approximation to the "true cost" of capital, i.e., the marginal opportunity cost of capital. It should be noted that the true rate is the yield to maturity, rather than the stated rate of interest on such securities.

In LDC's the critical conditions may not be met; alternative approaches to the estimation of the true cost of capital are required. In the absence of a free market in long-term issues by stable central governments with established records of prompt debt service, the best bases for estimation of the true cost of capital are low-risk, long-term private loans from commercial and special credit institutions, provided there are no government regulations requiring allocation of loans at preferential rates. The rates on high-grade corporate bonds may also provide guidance in the estimation of the true cost of capital. Other market rates that may be employed in the estimation include:

1. Rates of return on equity capital, before taxes. The usefulness of these rates is critically affected by the accuracy of depreciation, and by revaluation in periods of inflation. Also, the rates of return are likely to show considerable variation from year to year. Rates derived by this method will contain a large element reflecting risk, and should be used only as a last resort.

2. The ratio of profits before taxes plus interest payments to the depreciated value of physical assets, where information on the value of assets is available. Both the numerator and the denominator of this ratio should be expressed in the same prices, i.e., current or constant prices. The usefulness of this ratio as a basis for estimation of the real cost of capital depends on the accuracy of depreciation, the degree to which book values of assets reflect actual values, and the presence (or absence) of earnings attributable to factors other than physical costs.[1/]

1/ This approach to the estimation of the cost of capital was applied in the "India Coal Transport Study," by Surveys and Research Corporation, and Coverdale and Colpitts. A brief description of the methodology and a summary of the resulting estimates are given in a study (report no. EC-138) by IBRD-IDA staff, pp. 18-19.

3. In the absence of a superior basis on which to base an estimate of the cost of capital, the rates charged in unorganized or "curb" markets will provide some guidance. Such rates are almost always higher than those charged by formal financial institutions -- mostly because of the high risks usually involved in such loans, but also because of the frequent monopolistic position of lenders in rural areas and the small size of many such loans, which results in a high ratio of administrative costs to the principal of such loans.

Adjustment for Inflationary Trends

In countries experiencing persistent inflationary trends, market interest rates generally include an element to compensate the lender for the (probable) decline in the purchasing power of the loans between the time the loan is made and its repayment. This is one of several types of premiums to compensate for risk -- in this case, the risk of inflation. This premium is likely to be reflected in all market interest rates on fixed currency obligations -- regardless of the freedom from other types of risk.

Insofar as possible, estimation of the cost of capital should exclude the premium to compensate the lenders for loss in real purchasing power arising from inflation. If informed sources have a firm expectation that the general price level will rise by, say, 8 percent per annum over the life of the project, and the best estimate of the market rate of the cost of capital (based on one or more of the sources noted above) is say 22 percent per annum, a marginal opportunity real cost of capital of around 14 percent would be closer to the appropriate shadow rate than the 22 percent.

If long-term securities requiring repayment in local currency of equivalent purchasing power are available, the differential in yield to maturities of these and fixed currency obligations of comparable risks, maturities, etc. provide a useful measure of the inflationary risk premium in market rates.

As noted earlier, there is no completely satisfactory method for ascertaining the cost of capital for application in project appraisals. While rates that would emerge from sophisticated economic models are conceptually free of some

of the limitations inherent in estimates based on the empirical partial procedures suggested, these more elegant solutions are generally not feasible, at least in LDC's. As noted in a staff study of the International Bank for Reconstruction and Development:

> Application of estimates of the cost of capital in the evaluation of projects obviously requires great caution. But clearly also, if action is to be taken at all, the problem cannot be avoided and a critical attitude must be accompanied by a positive judgment, however tentative this may be.1/

The Accounting Wage Rate for Unskilled Labor

In principle, this accounting price should be based on the net cost, to the national economy, of the input of unskilled labor into the project under review. Assuming the project is being evaluated in terms of its prospective rate of return to capital, the net cost will be composed of essentially two elements:

1. The output of the worker in his present employment, from which it is assumed he would transfer to the project

2. The additional consumption and other demands on output attributable to employment in the particular project.

For the first of these components, totally unemployed workers would have a marginal opportunity cost of zero. For underemployed, unskilled workers, the marginal opportunity cost will be something more than zero, but probably less than the going market wage rate for the type of labor. For

1/ IBRD-IDA, "On Estimating the Economic Cost of Capital," Report No. EC-138, 1965, p.21.

the underemployed worker, the best estimate of the first component noted above can be made from the answer to the question, "By how much would the total value of output be reduced if the worker were withdrawn from his present (under) employment?"

The second component of the marginal opportunity cost of unskilled labor is almost certain to be greater than zero, but less than the total expenditures for consumption by the worker newly employed in the project. The underemployed -- and even the totally unemployed -- consume something. From a broader welfare appraisal the additional consumption accompanying the employment would, of course, be a benefit that would appear as an output as well as an input, i.e., as a component of the marginal opportunity cost of the labor.

Where data exist, a rough estimate of the second component of the marginal opportunity cost of unskilled labor may be made by comparing consumption levels of unemployed and underemployed unskilled workers with consumption of fully employed unskilled workers, and treating the difference as the additional cost of utilization of unskilled labor in the project and is a component of the marginal opportunity cost of the labor input.

The incremental, real economic cost of employment versus unemployment or substantial underemployment may include such elements as the resources required to provide training; additional requirements for food, clothing and medical care; the costs of social infrastructure that may be necessary as the rural unemployed and underemployed shift to urban jobs; and transportation to and from the place of employment. It is only to the extent that the output of the worker exceeds these increments in the costs of his maintenance (plus any loss in real output in his present employment) that employment of the worker will yield any positive return on the capital employed in the project.

In LDC's large numbers of unemployed and underemployed members of the labor force usually reflect the constraints of capital shortages and the lack of foreign exchange -- as well as structural rigidities and imperfections in the labor market(s). Not uncommonly, money wage rates are established in the urban industrial sectors (or in modern plantation

agricultural schemes) of what are essentially dual economies. The money wage rates so established tend to become the "norms" which employers in the modern sector are expected to pay as requirements for additional workers are met, either from the urban unemployed or the rural underemployed. These norms are often supported by unionized workers, and/or by government regulations or less formal policies. In fact, the productivity of workers may well exceed their wages given the constraints noted above on the expansion of employment; but from the standpoint of project evaluation in terms of the net returns to the economy, the relevant real cost of labor is the marginal opportunity cost of its employment on the project in question -- not the money wage which is necessary to put the worker in productive employment.

Accounting or Shadow Rate of Foreign Exchange

In many -- if not most -- LDC's, the domestic monetary unit tends to be overvalued. Thus, imported inputs tend to be too cheap, relative to domestic inputs; and the values of exported outputs, expressed in the domestic monetary unit, are also understated. These distortions can give rise to serious bias in project appraisal -- even at the preliminary stage. The choice of construction technology is especially sensitive to the foreign exchange rate. In the evaluation of projects involving substantial imported inputs and/or exports of output, the use of an accounting exchange rate will improve the basis of the appraisal, even if foreign exchange controls and quantitative restrictions on imports impose limits on the effective demands for foreign goods.

One approach to the estimation of an accounting rate of exchange is through comparisons between the wholesale prices of imported and domestically produced goods considered to be perfect substitutes, disregarding import duties and internal excise taxes. Thus, if the price of domestically produced portland cement, for example, is 25 percent above world market prices (c.i.f. plus local handling costs), the presumption is that the ratio of the accounting exchange rate to the official rate is 1.25/1.00, insofar as this one good is concerned. If similar comparisons can be made for a large number of goods, or in terms of a broadly based, representative wholesale price index, the resulting ratio can be used as a correction factor to estimate an accounting exchange rate.

Alternatively, where there is a substantial volume of foreign trade, "effective rates" of exchange for imports and exports may be of use in estimating the accounting or shadow rate of exchange. However, if import licenses are denied for significant quantities of important commodities, the effective rate will be below the appropriate level for the accounting or shadow rate of exchange.

An effective rate of exchange on imports may be computed by dividing the sum of domestic c.i.f. cost of imports plus all duties, port charges, customs clearance and import license fees, and penalty interest on deposits required to obtain import licenses, by the c.i.f. value of imports expressed in foreign currency. A similar computation may be made to arrive at an effective rate of exchange for exports. To the official exchange receipts from exports all subsidies -- direct and indirect -- would be added, and the total divided by the f.o.b. value of the export expressed in foreign currency. In this computation, it is important to include all indirect forms of subsidy, including loans at preferential interest rates, the profits from sales of privileged imports available only to exporters, lower transport and electric rates for exporters, etc., as well as direct subsidies.

For some developing countries, independent market rates of foreign exchange may be available from published (or easily obtainable) quotations in free markets outside the country. However, such market quotations should be used with extreme caution, as they often reflect illicit transactions or very limited volumes of exchange. Similarly, black-market rates within a country are not generally an appropriate base for an accounting exchange rate. These rates are generally set in very thin markets in which both buyers and sellers are frequently engaged in illicit transactions involving high risks.

In many countries, central monetary authorities compute more or less continuously what is generally called the "effective rate of exchange." The method of computation generally follows that suggested in the second alternative above. Where available, these are probably satisfactory bases for the estimation of the accounting exchange rate, subject to the qualifications noted above.

Taxes and Pricing in the Net National Rate of Return

In general, taxes imposed in the production process should be excluded as costs (inputs) in project appraisal, from the standpoint of the prospective returns to the economy. This applies to import and export duties, as well as to internal taxes on commodities and raw materials. The rationale for the exclusion is that taxes do not represent a social cost, as distinguished from a private or enterprise cost of obtaining the output. In this context tax receipts are viewed as a share of the benefits of the project allocated to government, rather than an economic cost.

Pricing of Outputs

Prevailing market prices, and price projections based thereon, provide satisfactory "weights" for estimation of the value of output if a project is being evaluated from the standpoint of the enterprise rate of return. But in most LDC's, such prices are not likely to provide an accurate measure of the real value of output viewed from the standpoint of the economic returns (NNRR) on a project.

In LDC's, markets for many products are highly imperfect, with prices set by few buyers and sellers, price determination by administrative action, the compartmentalization of markets because of inadequate transport and communication, etc. Prices in such markets are an imperfect guide, at best, to the estimation of the national economic value of output from prospective projects.

Where output will consist of marketable products (i.e., divisible goods which can be sold for a price) and such goods are traded in world markets, the c.i.f. price (exclusive of duties) provides a satisfactory base for valuation of domestic output -- if a "correct" exchange rate is employed in converting the foreign to the domestic currency value. If both non-labor inputs and outputs consist largely of goods traded in world markets, it may be useful to use world prices for the computation of an NNRR, with domestic labor inputs converted to world prices by use of the accounting rate of foreign exchange.

Although there is no completely satisfactory method of determining "correct prices" in the absence of reasonably free, competitive markets, the analyst should be alert to the price distortions arising from such factors as those cited above, from clearly temporary shortages, and from disruptions in supply and inflation. By using accounting prices, rather than actual prevailing prices, estimates can be improved in these circumstances.

It is especially important to make allowance for probable future price changes that will result if the project under review will provide a large addition to the short supply of a good having an inelastic demand. For example, the value of output of large-scale agricultural projects can all too easily be overestimated by the failure to take into account the effects of increased agricultural output on prices during the life of the project.

External Costs and Benefits

In chapter III, attention was directed to certain inputs, the costs of which are not actually paid by an enterprise. The inclusion of such costs is appropriate if the project is being appraised from the standpoint of the rate of return to the economy because they are borne somewhere in the economy. For example, air and water pollution may impose real costs on the population in the form of illnesses and medical expenses. Access roads and streets, water and sewerage services and other infrastructure, to the extent required for the project, are properly considered as economic costs of the project whether or not the expense of providing them is actually borne by the project.

An analogous situation exists with respect to outputs (benefits) on which an enterprise is not able to impose a price and, therefore, collect revenues. The extreme cases of such benefits are found in the government sector: national security, fire and police protection, education, public health, etc.

In some types of projects, e.g., development roads, the external benefits may be so important that the proposed road can be properly evaluated only by consolidation with the land development schemes or other developments that it will serve.

APPENDIX C. CHECKLIST FOR THE PRELIMINARY PROJECT APPRAISAL

Purpose

The purpose of this checklist is to:

1. Suggest sources and types of information useful for the PPA;

2. Identify the elements requiring examination and assessment as background for the PPA;

3. Note the principal factors to be considered in the formulation of the project and the testing of alternatives;

4. Signal where further investigation, study and action are required to help assure a successful outcome of the project and to avoid likely pitfalls. Quite often, early knowledge about potential difficulties will permit arrangements that can eliminate or minimize the difficulty.

Where information is called for in the checklist but is not readily available for the preliminary appraisal, a notation of its absence can serve as a reminder for later stages of study. If such information is critical for the preliminary appraisal, its absence may signal the need to suspend the preliminary appraisal, rather than to permit sheer momentum to carry it on.

Common Sources of Information

. Basic economic data: Central planning boards, Ministry of Finance, Ministry of Public Works, foreign trade statistics, central banks

. Sectoral economic data: From concerned ministries and agencies such as Agriculture, Housing, Labor, Commerce and Industry, Communications, Transport, and Power

. Marine Charts - Naval offices, and shipping companies

. Meteorological Data - Hydrologic officer, airlines, local highway and railroad engineers

. Geology - Geological and mineral surveys, mining or extractive processing companies, well drillers, local highway and railroad engineers

. Population and Commerce - Banks, local educational institutions and businesses (utilities, manufacturing enterprises, wholesalers, importers, exporters), censuses and special surveys

. Transportation - Airlines, vehicle registrars, railroads, shipping companies, petroleum companies, brokers and agents.

Most of the sources listed above will be found in the majority of LDC's. However, it will usually be advisable to assemble as much information as possible from secondary sources such as UN publications and country reports of the World Bank and AID.

Review of Existing Conditions and Experience Relevant to the Project

Which activities in the country resemble most closely the proposed project?

Has the experience with such activities been reviewed with reference to important matters such as:

1. The causes of cost overruns and delays in construction

2. Labor difficulties or labor practices that affect operations (termination allowances, shift differentials, holidays, overtime, etc.)

3. Government regulations

4. Restrictions on importation or disposal of construction equipment

5. Performance of local contractors and subcontractors

6. Rates of utilization of capacity. If significant underutilization has been experienced, what are the reasons?

7. Availability of skilled personnel for management, construction and operation

8. Problems encountered in obtaining materials, imported or domestic

9. Reliability and availability of power output

10. Effects of climate on types of project similar to those being appraised

11. Reliability and availability of transportation and communication

12. Escalation of construction costs

13. Availability of operating funds, supplies, spare parts, foreign exchange, etc.

14. Attitude towards foreign participation.

Can difficulties encountered in previous projects of a similar nature be expected in the proposed project? Does the project as planned assume that there will be similar difficulties? If not, what specific steps are being planned to avoid or minimize such difficulties?

Engineering and Technical Data Requirements

Capital projects involve combinations, enlargement, improvements and modernization of physical assets. Hence, it is necessary at the outset of an appraisal to ascertain that it is physically possible to implement a proposed project, and to establish the physical characteristics of the proposed project in sufficient detail to permit order-of-magnitude[1/] estimates of construction and operating costs. The required detail will be significantly less for a preliminary project appraisal than for full-scale feasibility studies and the preparation of prebid estimates.

There is no way to define accurately the precise amount of engineering and technical study that will be required for all PPA's. There are, however, guidelines which will assist the analyst, if used in the broad sense. When the project, or alternatives, have been identified, the following technical data will be required.

1. Has the planned location of the facility been justified in terms of the following requirements:

1/ An order-of-magnitude estimate is made without detailed engineering; it is expected to have an accuracy of +50 to -30 percent.

a. Topography - is the terrain suitable?

b. Geology - is the area buildable, e.g., are faults present?

c. Ecology - is the facility likely to affect surrounding community by air, water, noise pollution; safety factors; adverse effect on use of adjacent lands?

d. Availability - is sufficient area available on a timely basis?

e. Best use - is this the best site - is it too good for the planned use?

2. Is adequate local skilled and unskilled available? Are training facilities available?

3. Is basic building material (sand, gravel, cement, fertilizers, steel) available locally? Is the grade adequate?

4. Is sufficient water of required quality readily available?

5. Is sufficient power or power source readily available?

6. Are the local building standards adequate and reasonable?

7. Are local manufactured products available? Is quality adequate; are probable delivery times reasonable?

8. Is local construction equipment of adequate size and performance available?

9. Are competent subcontractors available?

10. Is adequate fuel (equipment) available?

11. Are maintenance and machine shop facilities available?

12. What are the electric power characteristics: voltage, cycle, etc.?

If sufficient time or data do not permit a reliable answer to the above questions, the analyst should qualify his answers by assigning a percent confidence level or probability of error factor to each significant point. For example, if the available building material (cement, gravel, sand) has not been tested for standard strength and grade, the investigator would be required to estimate its quality by personal inspection and by inspection of structures constructed with the material. He would then assign a percent factor reflecting his degree of certainty as to its quality.

Shaping the Project

What major alternatives to perform the same or similar function have been considered and rejected on the basis of:

- Restraining circumstances (specify)
- Economic, engineering, institutional, and attitudinal considerations (specify)?

Are there some alternatives that should be considered in later stages of study of the project?

List the major sources of uncertainty about the project and how the project has been changed to cope with the uncertainty.

Estimation of Costs

Describe:

- Basis of costing of the project, i.e., proposed size and technical characteristics of project as these affect cost
- Estimated level of cost in relation to other countries; in relation to similar projects in the country
- Use of scaling
- Major units of costing; costing by modules, and adjustment of module prices to local conditions
- Allowance for cost escalation during construction
- Allowance for training costs
- Allowance for startup costs
- Allowance for substandard service facilities
- Allowance for other cost considerations.

What is the basis for deciding when to use imported materials, particularly when indigenous materials are available?

Describe the outer limits of estimated investment required by the project and the factors that are most likely to raise costs.

Enumerate the standards that have been adopted for the construction and the operation of the project. What are the other standards that were considered? Give the basis for their rejection.

Does the estimate of investment cost include investments needed to obtain services such as:

- Maintenance or improvement of public highways, water courses or communications to service project
- Procurement or financing the procurement of railroad rolling stock or improvements to track
- Purchase and supply of materials and equipment for expansion or maintenance of water, sewer, gas, electric or other utility systems connected to the project
- Expansion costs of public institutions, including medical services, to serve the project's population
- Relocation of persons displaced by the project.

Estimation of Demand and Valuations of Output

The physical characteristics of the project will be determined, in part, by the planned or projected output. In this connection, the PPA is directed to:

1. Examination of the economic , demographic and institutional factors that are expected to determine the quantities demanded -- if the output is to be distributed through the market.

2. Assessment of the need for services to be provided through infrastructure projects where market prices are not relied upon to control quantities demanded, e.g., education, public health and (some) transport facilities

3. Estimation of the probabilities of the projected needs or demands being realized

4. Valuation of projected output:

a. At market prices

b. At accounting or shadow prices

5. Special problems of valuation for projects having outputs not sold for a price

a. Indirect (external) benefits, e.g., linkage effects

b. Indivisible benefits, e.g., improved public health and environment

6. Selection of least-cost alternatives where quantification and/or monetary valuation of output is not feasible.

Organization and Management

Identification of Project Sponsorship

1. Policy-makers. Extent to which:

a. Policy-makers have participated actively in defining the project

b. Crucial policy options have been identified and are reflected in the definition of the project

c. Positions of the policy-makers are reflected in the definition of the project

d. Preliminary appraisal provides the approximate economic returns of different major policy options.

2. Sponsoring entities. Extent to which:

a. Government agencies (central, regional, provincial, municipal and other local) and quasigovernmental organizations participated in defining the project proposal

b. Private entrepreneurs or private promoters participated in definition of project

c. International lending agencies and other foreign sources, including consultants and equipment suppliers, participated in project definition

d. Other organizations, not designated as sponsoring organizations, participated in definition of project.

Organizational Structure or Form

1. Description of organization proposed to manage and supervise the project operations together with functional, operating and maintenance organization charts, present (if applicable) and projected.

2. Relationship of the proposed organizational form to the managerial requirements of the project.

3. Does proposed organizational structure reflect the work and kinds of operating and maintenance activities required to accomplish the project objectives?

4. Extent to which project involves unusual organizational complexity, and to which organizational structure reflects the technology of the project.

5. Does project require unusual organizational coordinative arrangements with other agencies and depend on effective interface relationships with other organizations in support of project objectives?

6. Extent to which organization charts reflect (a) the intended legal or formal overall structure of the organization, and (b) the manner in which the day-to-day operations of the organization are intended to be carried out.

Legal Arrangements

1. Description in general way of arrangements required to legalize the proposed project, including, as applicable, laws to be drafted; governmental directives to be issued or modified; agreements with central and local government authorities to be negotiated; documents to be drawn up between the government, international lending agencies, project investors, and other entities; and estimate of time to complete these arrangements.

2. General description of government authorizations to be issued (e.g., investment incentives, subsidies, tax and import duty exemptions, price and tariff decisions, etc.), and estimate of time to complete these arrangements.

Management Authority and Autonomy: General Discussion

1. Will the autonomy needed for effective project management be limited by the government's need for coordinated development policy, by political factors, or by other reasons?

2. Will project management be able to operate under the preferred budgetary and financial arrangements?

3. Will the project management be able to exercise control over the allocation and utilization of all resources (men, money, facilities, equipment and supplies) approved in the project?

4. Will the project management have necessary autonomy in the selection of key personnel and in conditions of their employment, or will undue interferences be likely?

5. Are limitations likely to be placed on the authority of the management to make enforceable policy and operating decisions required by the project in other areas?

6. Which structural changes will be necessary in an existing parent organization in order to operate and maintain the project properly?

7. Extent to which organizational alternatives have been considered and the justification (advantages and disadvantages) of proposed organizational form.

Availability of and Arrangements for Training Required Managerial and Technical Personnel

1. Description of requirements for managerial and technical personnel for the proposed project as defined by the preliminary organization plan, including position specifications, desired qualities, and salary ranges

2. Indication of availability of suitable general manager of the project and of other key personnel

3. Extent to which other managerial and technical manpower requirements are likely to be met from existing sources, domestic and foreign, public and private

4. Planned or projected arrangements for meeting gaps between requirements and availabilities, e.g., executive development and technical training programs, part-time employment of locally available managers and technicians, hiring of foreign consultants as temporary executives and trainers, etc.

Availability of and Arrangements for Training Required Skilled Labor and Meeting Unskilled Labor Requirements

1. Description of requirements for skilled labor, unskilled labor, and casual labor (if any) as defined by the proposed work schedule, including job specifications, wage rates and other provisions. In a general way there should be manning tables which show the types and degrees of skills required both for operating and maintenance functions, and these should be tied in with the organization charts and job descriptions in terms that fit the local situation.

2. Planned or projected arrangements for meeting gaps between requirements and prospective availabilities.

Availability and Development of Organizational Headquarters Physical Facilities

1. General description of space, office, communication and other equipment, and other facilities required by the project organization

2. Extent to which proposed project organization will depend on facilities provided by cooperating or subordinate organizations

3. Extent to which new facilities will be required

4. Projected arrangements for meeting requirements for organizational physical facilities.

Other Considerations

1. Degree to which the quality and traditions of administration of the project's environment are likely to influence the successful organization and management of the project

2. Degree to which existing or pending legislation and governmental regulations are likely to affect organization and management of the project, including pending economic and social legislation, administrative reforms, and (as applicable) such legal considerations as concessions, conventions, franchises, rights-of-way, permits, licenses, etc.

3. Extent to which social implications of the project are likely to affect organization and management of the project

4. Extent to which overall environmental factors (international as well as national) are likely to affect the organization and management of the project.

APPENDIX D. PRESENT VALUE DISCOUNT FACTOR FOR SINGLE PAYMENT AND CONTINUOUS PAYMENT FOR GROWTH RATES OF 3 PERCENT TO 50 PERCENT

Table D-1. Single Payment Present Worth Factors for Growth Rates From 3 Percent to 50 Percent

	Growth Rate																	
Year	3%	4%	5%	6%	7%	8%	10%	12%	13%	14%	15%	20%	25%	30%	35%	40%	45%	50%
1	.9709	.9615	.9524	.9434	.9346	.9259	.9091	.8929	.8850	.8772	.8696	.8333	.8000	.7692	.7407	.7143	.6897	.6667
2	.9426	.9246	.9070	.8900	.8734	.8573	.8264	.7972	.7831	.7695	.7561	.6944	.6400	.5917	.5487	.5102	.4756	.4444
3	.9151	.8890	.8638	.8396	.8163	.7938	.7513	.7118	.6930	.6750	.6575	.5787	.5120	.4552	.4064	.3644	.3280	.2963
4	.8885	.8548	.8227	.7921	.7629	.7350	.6830	.6355	.6133	.5921	.5718	.4823	.4096	.3501	.3011	.2603	.2262	.1975
5	.8626	.8219	.7835	.7473	.7130	.6806	.6209	.5674	.5428	.5194	.4972	.4019	.3277	.2693	.2230	.1859	.1560	.1317
6	.8375	.7903	.7462	.7050	.6663	.6302	.5645	.5066	.4803	.4556	.4323	.3349	.2621	.2072	.1652	.1328	.1076	.0878
7	.8131	.7599	.7107	.6651	.6227	.5835	.5132	.4523	.4251	.3996	.3759	.2791	.2097	.1594	.1224	.0949	.0742	.0585
8	.7894	.7307	.6768	.6274	.5820	.5403	.4665	.4039	.3762	.3506	.3269	.2326	.1678	.1226	.0906	.0678	.0512	.0390
9	.7664	.7026	.6446	.5919	.5439	.5002	.4241	.3606	.3329	.3075	.2843	.1938	.1342	.0943	.0671	.0484	.0353	.0260
10	.7441	.6756	.6139	.5584	.5083	.4632	.3855	.3220	.2946	.2697	.2472	.1615	.1074	.0725	.0497	.0346	.0243	.0173
11	.7224	.6496	.5847	.5268	.4751	.4289	.3505	.2875	.2607	.2366	.2149	.1346	.0859	.0558	.0368	.0247	.0168	.0116
12	.7014	.6246	.5568	.4970	.4440	.3971	.3186	.2567	.2307	.2076	.1869	.1122	.0687	.0429	.0273	.0176	.0116	.0077
13	.6810	.6006	.5303	.4688	.4150	.3677	.2897	.2292	.2042	.1821	.1625	.0935	.0550	.0330	.0202	.0126	.0080	.0051
14	.6611	.5775	.5051	.4423	.3878	.3405	.2633	.2046	.1807	.1597	.1413	.0779	.0440	.0254	.0150	.0090	.0055	.0034
15	.6419	.5553	.4810	.4173	.3624	.3152	.2394	.1827	.1599	.1401	.1229	.0649	.0352	.0195	.0111	.0064	.0038	.0023
16	.6232	.5339	.4581	.3936	.3387	.2919	.2176	.1631	.1415	.1229	.1069	.0541	.0281	.0150	.0082	.0046	.0026	.0015
17	.6050	.5134	.4363	.3714	.3166	.2703	.1978	.1456	.1252	.1078	.0929	.0451	.0225	.0116	.0061	.0033	.0018	.0010
18	.5874	.4936	.4155	.3503	.2959	.2502	.1799	.1300	.1108	.0946	.0808	.0376	.0180	.0089	.0045	.0023	.0012	.0007
19	.5703	.4746	.3957	.3305	.2765	.2317	.1635	.1161	.0981	.0829	.0703	.0313	.0144	.0068	.0033	.0017	.0009	.0005
20	.5537	.4564	.3769	.3118	.2584	.2145	.1486	.1037	.0868	.0728	.0611	.0261	.0115	.0053	.0025	.0012	.0006	.0003
21	.5375	.4388	.3589	.2942	.2415	.1987	.1351	.0926	.0768	.0638	.0531	.0217	.0092	.0040	.0018	.0009	.0004	.0002
22	.5219	.4220	.3418	.2775	.2257	.1839	.1228	.0826	.0680	.0560	.0462	.0181	.0074	.0031	.0014	.0006	.0003	.0001
23	.5067	.4057	.3256	.2618	.2109	.1703	.1117	.0738	.0601	.0491	.0402	.0151	.0059	.0024	.0010	.0004	.0002	.0001
24	.4919	.3901	.3101	.2470	.1971	.1577	.1015	.0659	.0532	.0431	.0349	.0126	.0047	.0018	.0007	.0003	.0001	.0001
25	.4776	.3751	.2953	.2330	.1842	.1460	.0923	.0588	.0471	.0378	.0304	.0105	.0038	.0014	.0006	.0002	.0001	.....
26	.4637	.3607	.2812	.2198	.1722	.1352	.0839	.0525	.0417	.0331	.0264	.0087	.0030	.0011	.0004	.0002	.0001	.....
27	.4502	.3468	.2678	.2074	.1609	.1252	.0763	.0469	.0369	.0291	.0230	.0073	.0024	.0008	.0003	.0001	.....	.....
28	.4371	.3335	.2551	.1956	.1504	.1159	.0693	.0419	.0326	.0255	.0200	.0061	.0019	.0006	.0002	.0001	.....	.....
29	.4243	.3207	.2429	.1846	.1406	.1073	.0630	.0374	.0289	.0224	.0174	.0051	.0015	.0005	.0002	.0001	.....	.....
30	.4120	.3083	.2314	.1741	.1314	.0994	.0573	.0334	.0256	.0196	.0151	.0042	.0012	.0004	.0001	.....	.....	.....
31	.4000	.2965	.2204	.1643	.1228	.0920	.0521	.0298	.0226	.0172	.0131	.0035	.0010	.0003	.0001	.....	.....	.....
32	.3883	.2851	.2099	.1550	.1147	.0852	.0474	.0266	.0200	.0151	.0114	.0029	.0008	.0002	.0001	.....	.....	.....
33	.3770	.2741	.1999	.1462	.1072	.0789	.0431	.0238	.0177	.0132	.0099	.0024	.0006	.0002	.0001	.....	.....	.....
34	.3660	.2636	.1904	.1379	.1002	.0730	.0391	.0212	.0157	.0116	.0086	.0020	.0005	.0001	.....	.....	.....	.....
35	.3554	.2534	.1813	.1301	.0937	.0676	.0356	.0189	.0139	.0102	.0075	.0017	.0004	.0001	.....	.....	.....	.....

Table D-2. Present Worth Factors for Growth Rates From 3 Percent to 50 Percent, Continuous Flow Compounded at Annual Rate

Period	Growth Rate															
	3%	4%	5%	6%	7%	8%	10%	12%	15%	20%	25%	30%	35%	40%	45%	50%
0 to 1	.9854	.9806	.9760	.9714	.9669	.9625	.9538	.9454	.9333	.9141	.8963	.8796	.8639	.8491	.8352	.8221
1 to 2	.9567	.9429	.9295	.9164	.9037	.8912	.8671	.8441	.8115	.7618	.7170	.6766	.6399	.6065	.5760	.5481
2 to 3	.9288	.9067	.8853	.8646	.8445	.8252	.7883	.7537	.7057	.6348	.5736	.5205	.4740	.4332	.3973	.3654
3 to 4	.9017	.8718	.8431	.8156	.7893	.7641	.7166	.6729	.6136	.5290	.4589	.4004	.3511	.3095	.2740	.2436
4 to 5	.8755	.8383	.8030	.7695	.7377	.7075	.6515	.6008	.5336	.4408	.3671	.3080	.2601	.2210	.1889	.1624
5 to 6	.8500	.8060	.7647	.7259	.6894	.6555	.5922	.5365	.4640	.3674	.2937	.2369	.1927	.1579	.1303	.1083
6 to 7	.8252	.7750	.7283	.6848	.6443	.6065	.5384	.4790	.4035	.3061	.2350	.1822	.1427	.1128	.0899	.0722
7 to 8	.8012	.7452	.6936	.6461	.6021	.5616	.4895	.4277	.3508	.2551	.1880	.1402	.1057	.0806	.0620	.0481
8 to 9	.7779	.7165	.6606	.6095	.5628	.5200	.4450	.3818	.3051	.2126	.1504	.1078	.0783	.0575	.0427	.0321
9 to 10	.7552	.6890	.6291	.5750	.5259	.4815	.4045	.3409	.2653	.1772	.1203	.0829	.0580	.0411	.0295	.0214
10 to 11	.7332	.6625	.5992	.5424	.4915	.4458	.3677	.3044	.2307	.1476	.0962	.0638	.0430	.0294	.0203	.0143
11 to 12	.7118	.6370	.5706	.5117	.4594	.4128	.3343	.2718	.2006	.1230	.0770	.0491	.0318	.0210	.0140	.0095
12 to 13	.6911	.6125	.5435	.4828	.4293	.3822	.3039	.2427	.1744	.1025	.0616	.0378	.0236	.0150	.0097	.0063
13 to 14	.6710	.5889	.5176	.4554	.4012	.3539	.2763	.2167	.1517	.0854	.0493	.0290	.0175	.0107	.0067	.0042
14 to 15	.6514	.5663	.4929	.4297	.3750	.3277	.2512	.1935	.1319	.0712	.0394	.0223	.0129	.0076	.0046	.0028
15 to 16	.6325	.5445	.4695	.4053	.3505	.3034	.2283	.1727	.1147	.0593	.0315	.0172	.0096	.0055	.0032	.0019
16 to 17	.6140	.5236	.4471	.3824	.3275	.2809	.2076	.1542	.0997	.0490	.0252	.0132	.0071	.0039	.0022	.0013
17 to 18	.5962	.5034	.4258	.3608	.3061	.2601	.1887	.1377	.0867	.0412	.0202	.0102	.0053	.0028	.0015	.0008
18 to 19	.5788	.4841	.4055	.3403	.2861	.2409	.1716	.1229	.0754	.0343	.0161	.0078	.0039	.0020	.0010	.0006
19 to 20	.5619	.4655	.3862	.3211	.2674	.2230	.1560	.1098	.0656	.0286	.0129	.0060	.0029	.0014	.0007	.0004
20 to 21	.5456	.4476	.3678	.3029	.2499	.2065	.1418	.0980	.0570	.0238	.0103	.0046	.0021	.0010	.0005	.0002
21 to 22	.5297	.4303	.3503	.2857	.2335	.1912	.1289	.0875	.0496	.0199	.0083	.0036	.0016	.0007	.0003	.0002
22 to 23	.5143	.4138	.3336	.2696	.2182	.1770	.1172	.0781	.0431	.0166	.0066	.0027	.0012	.0005	.0002	.0001
23 to 24	.4993	.3979	.3178	.2543	.2040	.1639	.1065	.0698	.0375	.0138	.0053	.0021	.0009	.0004	.0002	.0001
24 to 25	.4847	.3826	.3026	.2399	.1906	.1518	.0968	.0623	.0326	.0115	.0042	.0016	.0006	.0003	.0001	.....
25 to 26	.4706	.3679	.2882	.2263	.1782	.1405	.0880	.0556	.0284	.0096	.0034	.0012	.0005	.0002	.0001	.....
26 to 27	.4569	.3537	.2745	.2135	.1665	.1301	.0800	.0497	.0247	.0080	.0027	.0010	.0004	.0001	.0001	.....
27 to 28	.4436	.3401	.2614	.2014	.1556	.1205	.0728	.0443	.0214	.0067	.0022	.0007	.0003	.0001	.....	....
28 to 29	.4307	.3270	.2490	.1900	.1454	.1116	.0661	.0396	.0186	.0055	.0017	.0006	.0002	.0001	.....	.....
29 to 30	.4181	.3144	.2371	.1793	.1359	.1033	.0601	.0353	.0162	.0046	.0014	.0004	.0001	.....	.....	....
30 to 31	.4060	.3024	.2258	.1691	.1270	.0956	.0547	.0316	.0141	.0039	.0011	.0003	.0001	.....	.....	.....
31 to 32	.3941	.2907	.2151	.1596	.1187	.0886	.0497	.0282	.0123	.0032	.0009	.0003	.0001	.....	.....	.....
32 to 33	.3827	.2795	.2048	.1505	.1109	.0820	.0452	.0252	.0107	.0027	.0007	.0002	.0001	.....	.....	....
33 to 34	.3715	.2688	.1951	.1420	.1037	.0759	.0411	.0225	.0093	.0022	.0006	.0002	.....	.....	.....	....
34 to 35	.3607	.2585	.1858	.1340	.0969	.0703	.0373	.0201	.0081	.0019	.0005	.0001	.....	.....	.....	.....