Economic assessment of forestry project impacts

FAO FORESTRY PAPER

106

WORLD BANK

UNITED NATIONS ENVIRONMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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by

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FOREWORD

In 1979 FAO's Forestry Department published Forestry Paper No 17, Economic Analysis of Forestry Projects. This paper was used consistently as part of FAO's programme to strengthen the capability of those responsible for forestry sector analysis and planning and for project preparation and implementation. It was in great demand as training and reference material both by academic institutions and by forestry planners and economists.

By the end of the 80s the shift in emphasis in forestry development towards social and environmental concerns had added complexity to forestry sector and project work but it had not diminished the importance of a solid economic base. It was felt that the earlier publication needed to be checked both against new developments in project economics analysis and against the practical experience acquired in analysing the economic impacts of forestry projects over the decade. This concern was formally expressed by the Committee on Forest Development in the Tropics at its Ninth Session in September 1989 when it requested FAO to undertake an in-depth revision and updating of Paper No 17.

The present publication complies with this formal request. It also reflects the concern shared by FAO , UNEP and the World Bank that the scope of forestry project assessment be broadened to focus on impacts which translate effectively the role of forestry in sustainable development. This new publication is, in fact, part of a collaborative effort between the three Organizations to develop more holistic approaches to assess the economic, social and environmental impacts of forestry projects as a measure of their contribution to sustainable development. The publication is proof of this common effort and reflects a combination of the perspectives and experiences of the three Organizations. It is hoped that the impact assessment approaches recommended will be widely adopted as practical guidelines.

The publication was prepared by the Policy and Planning Division of the Forestry Department of FAO, under the direction of M.R. de Montalembert whose professional input is acknowledged, and with advice and assistance from UNEP, the World Bank, and other Departments in FAO. It was authored by H.M. Gregersen and A.H. Contreras, the authors of Forestry Paper No 17. H.M. Gregersen is Professor of Forestry and Agriculture and Applied Economics at the University of Minnesota, and A.H. Contreras, former senior forest economist with FAO's Forestry Department, serves the Asia Technical Department at the World Bank. Others who contributed to the writing of the publication are A. White, K. Christophersen, A. Lundgren, J.E.M. Arnold, T. Graham-Tomasi and K. Kanel. The Forestry for Sustainable Development Program of the University of Minnesota also contributed to this effort, and the World Bank's co-sponsorship was supported by a financial contribution from a Norwegian trust fund for environment and forestry economics.

The authors' preface spells out clearly the target audience of this publication. It is meant to be a practical guide which avoids unnecessary sophistication but which provides a powerful tool for more effective cooperation among foresters and economists working towards improving the economic base of sustainable forestry development. It is fervently hoped that this new publication will be most useful in strengthening capabilities for developing and implementing viable and sustainable forestry projects and activities.

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Authors' Preface

This paper is based on FAO's Forestry Paper 17 (*Economic Analysis of Forestry Projects*, or EAFP), produced by the authors back in 1979. The original document was published during a time when there was great enthusiasm in the international development community concerning the progress being made in social cost-benefit analysis. Interest in this subject has continued. Some excellent, practical publications have summarized and organized thinking over the past decade in the area of economic analysis of projects in general (cf. the World Bank's 1991 publication, *The Economics of Project Analysis: A Practitioner's Guide*, by William Ward and Barry Deren). We also have attempted to reflect the changes in thinking that have taken place over the past ten years in the specific area of economic assessment of forestry project impacts; and we have attempted to bring in those ideas which can practically be applied under field conditions (as distinct from longer term resarch conditions).

Thus, what appears in the following pages is a blend of academically *ideal* and time-worn, field tested approaches. The material presented thus is adaptable to practice in the field. The specific applications will have to reflect the various social, economic and political objectives found in different countries and should be used in an assessment framework that is consistent with institutional objectives and practice.

The Guidelines are written for government and nongovernmental development agency planners and related professionals in the forestry sector. Ideally, the readers are familiar with forestry projects of various types, have had at least an elementary exposure to economics, and understand the realities of planning in their own national contexts. A secondary audience is students in universities and professional courses and workshops who want to develop skills in economic assessment methodology as applied to forestry.

The present paper focuses mainly on public sector assessment needs and processes and brings in private individual and corporate assessment needs only as needed in the context of public sector planning.

The economic assessment process and procedures described in these guidelines already are being applied in a number of countries; and there are country level assessment guidelines for forestry already in existence. One might thus ask: "Why another set of guidelines?" There are several answers. First, while the process may be in use in the forestry sectors of many countries, there is no overall, systematic description of the process that is readily available for use at the level of expertise and breadth aimed at here. Second, a clear specification of procedure is essential to justify decisions based on economic criteria for controversial forestry projects. These guidelines hopefully help to provide such a clear specification. Third, in many countries the economic assessment process is only partially put into practice. The present guidelines provide a systematic framework for putting the whole process into practice. Fourth, systematic presentation of the economic assessment process as applied to forestry can be valuable for those who do not presently understand and apply it.

Introduction

Economic impact assessment is one of the tools used to provide information for making decisions about forestry projects. The objective of the present volume is to provide user-friendly guidelines to a practical approach for assessing the economic impacts of forestry projects.

The role of projects

Projects are a principal means governmental and nongovernmental organizations use to encourage and shape development. Successful development depends to a considerable degree on success in identifying, designing, implementing and managing projects which contribute to meeting goals.

Projects constitute a definable set of *inputs* that are transformed through *activities* into a definable set of *outputs*. Projects have impacts on people, both through the changes in outputs which they produce and through the activities that produce the outputs. It is these various impacts that are of concern in an economic assessment. The project development process involves a number of phases or stages as indicated in figure 1. As also indicated in figure 1, economic impact assessments are carried out at different stages in the project development process to provide decisionmakers with the information they need about economic and financial impacts as the process proceeds.

The role of economic impact assessments

Assessments are nothing more than systematic analyses. Economic impact assessments examine the socioeconomic and financial impacts of an activity, set of activities, or set of changes in a particular situation.

Assessments of likely economic impacts of potential or proposed projects are termed *ex ante* impact assessments. Assessments that are done after a project is implemented, looking back on what happened, are termed *ex post* assessments. The methodologies used for both ex ante and ex post impact assessments are similar. The major differences between ex ante and ex post assessments are in the purposes for the assessments, the kinds of information used in the assessments, and the ways in which that information is obtained.

Typically, *ex ante impact assessments* are conducted during the project identification and project preparation stage of the project process. They use estimates of future events and conditions. The purpose of an ex ante assessment is to provide information for decisionmakers to evaluate and make choices among project alternatives. Ex ante assessments deal with events that may (or may not) take place in the future. They must rely on uncertain estimates of these future events, and cope with a lack of information applicable to the particular circumstances under consideration. Because they deal with an uncertain future, strategies for dealing with uncertainty play a key role in ex ante assessments.

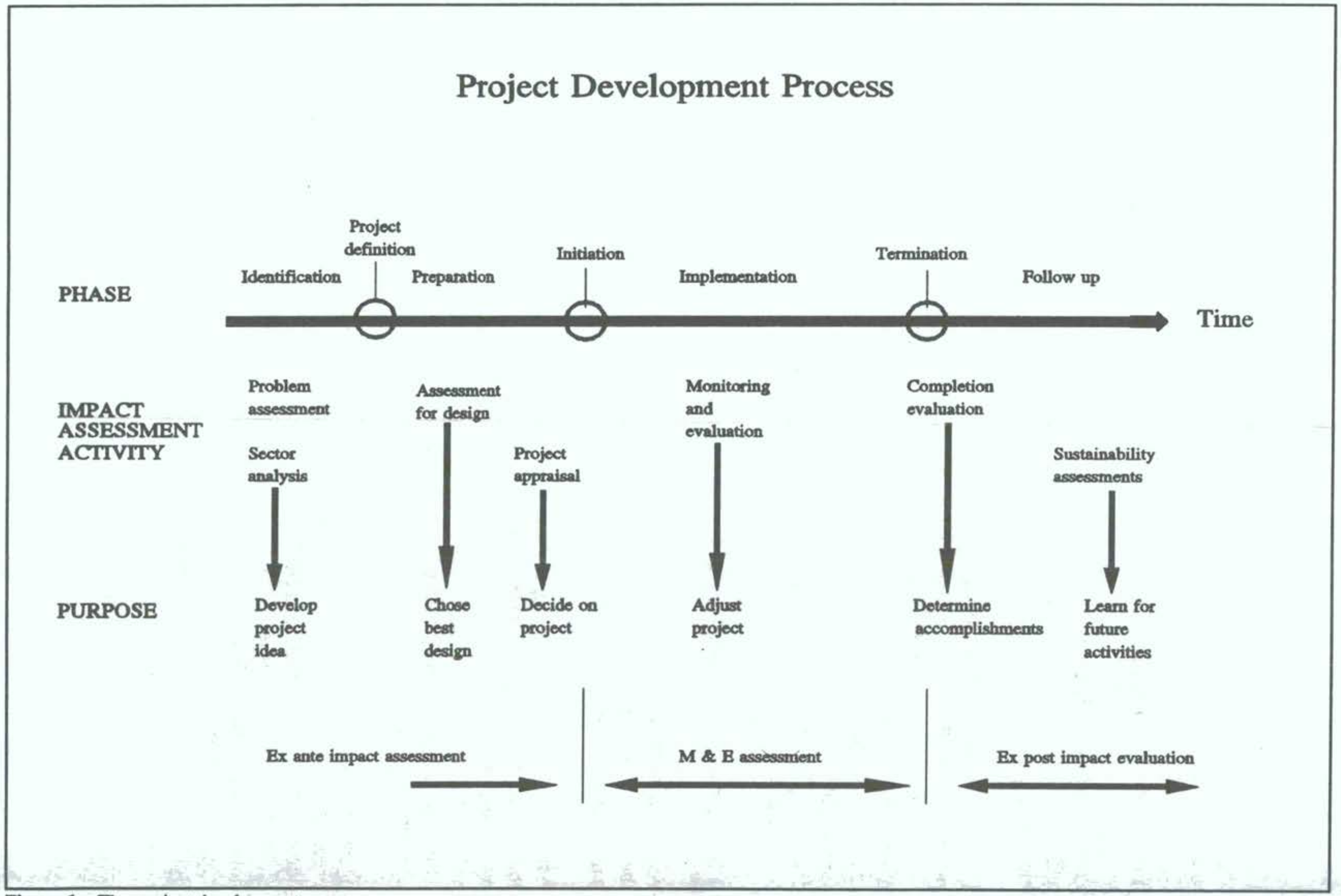

Figure 1. The project development process.

Ex post impact assessments are conducted after project completion, or after completion of certain segments of a project, e.g., during project implementation in a monitoring and evaluation activity. The purpose of an ex post assessment is to provide information for decisionmakers to help them judge the effectiveness and/or efficiency of completed projects, to improve the implementation of existing projects, and to improve ex ante assessments of future projects, i.e., to increase institutional learning. Ex post assessments deal with events that took place in the past. For information about these past events, analysts must rely on records of past events, or upon special studies to estimate the results of past activities if the funds, time, and expertise available and other considerations make this possible. Unfortunately, records of past events for many development projects may not be readily available. Records of past activities may never have been kept, or they may be missing, incomplete, inconvenient to assemble and use, unreliable, or inappropriate for the planned use.

Another type of assessment is the economic feasibility or performance assessment. The objective is to analyze, ex ante, the feasibility of some proposed project or action; and, ex post, the performance of a project or action. While these types of assessments are relevant and important for decisionmakers, the present guidelines deal only with ex ante and ex post *impact* assessments.

We need to stress here that economic impact assessment is not a mechanistic accounting exercise, but rather an attempt to assess in a variety of ways the real value to society and to individual groups within society of a project or activity. The intent is that such assessment provide background for making more informed decisions regarding the use of scarce resources available to society. Monitoring and evaluation assessments are important during the implementation of a project. They deal with events as they occur and, thus, the information generated can be used to steer the project in response to changing circumstances and to events as they are better understood. Monitoring and evaluation also provides information toward the end of a project that is useful in deciding what to do with the project at termination, e.g., to extend it, to reorient the project purpose, to expand it and so forth.

The economic assessment process

The *basic impact assessment process* is described in part I. It should be the same regardless of the stage in the project development process and regardless of the economic impact question being addressed. In carrying out the approach, the assessor, or assessment team, will be

1. specifying the questions to be answered (*see chapter 1);*
2. developing the overall assessment approach *(see chapter 2*);
3. answering the questions asked (the analysis process) (*see chapter 3*); and

The *basic economic assessment process* (step 3, answering the questions) is described in part II. This process also should be the same regardless of stage or question. It involves the following:

1. defining and quantifying the inputs and outputs of the project (*see chapter 4*);
2. estimating unit values (either market prices or economic values, depending on the question being answered) (*see chapter 5*);

3. calculating the relevant measures that will answer the questions being addressed (*see chapter 6*); and
4. dealing with issues of risk and uncertainty (sensitivity analysis) (*see chapter 7*);

Part I

The Economic Assessment Process

The purpose of part I is to explain the economic assessment process. Specific analysis techniques and principles are explained in part II under chapters which correspond to the main economic analysis activities—identifying inputs and outputs, valuing inputs and outputs, comparing costs and benefits, and dealing with uncertainty.

Figure I.1 indiates the three main steps in the economic assessment process, whether one is working at the project identification, planning, implementation, or termination stages of a project. These steps are explained in part I—presenting and using the results in the most effective way possible.

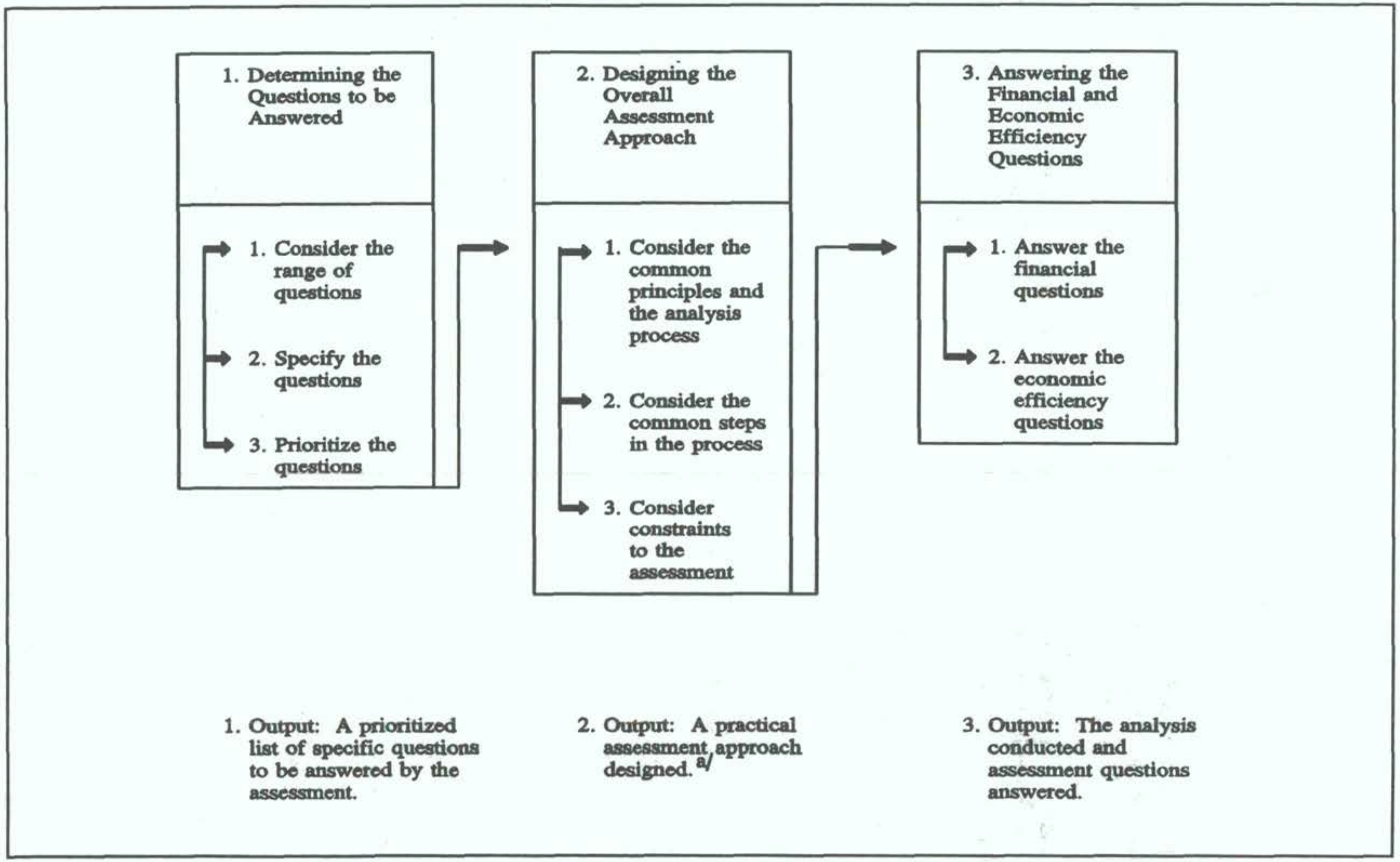

Figure I.1. Part I. The economic assessment process.

a/This amounts in most cases to selecting a set of techniques and the information which will be used.

1
Determining the Questions to be Answered

The first step in an impact assessment is to determine what questions it should answer, i.e., what are the key questions that those who are impacted by the project and those who make decisions about the project want answered? Broadly speaking, in the case of forestry projects, these groups include some or all of the following: government agencies, NGOs, coporations, rural inhabitants and farmers, forest owners and users of various types. All the groups that make decisions about, and are impacted by, a given project are referred to here as the *interested parties*.

In many cases, specifying the relevant questions in an operational form requires an interactive and iterative process involving the analyst and those making decisions about the project. There are two reasons why this type of interactive process is useful. First, decisionmakers may not have specified clearly enough the questions they are asking, thus creating confusion for the analyst. Second, certain relevant financial or economic efficiency questions may not occur to decisionmakers, even though they are quite relevant in the context of the project under consideration. By developing a clear specification of the questions to be answered, the analyst is essentially defining and refining the overall *purpose* of the assessment. Time and effort will be saved if this is done, and done well, prior to initiating the economic assessment.

1.1 Considering a Range of Questions

There are five basic financial and economic efficiency questions that are, or should be, of concern to the interested parties dealing with forestry projects of various kinds. These are as follows:

1.1.1 Financial questions (those related to actual expenditures and receipts)

1. *Is the project financially acceptable to the interested parties?* Do the interested parties (particularly private ones) have sufficient financial incentive to participate? What will be the cost and benefit flows to private investors or to participating farmers and landowners? If they do not find the project attractive enough, then it may be necessary to consider providing subsidies or other types of incentives. That is a main reason why this question is addressed.

2. *How are the returns and costs of the project distributed among the different interested parties?* This boils down to the question of who pays and who gains? It relates to the previous question and it is a question that also is of central concern in social impact assessments, where nonmonetary as well as monetary benefits and costs are included. Countries often are concerned with income redistribution effects of public investments, i.e., the equity issue. In most projects, concern centers on different income classes (do poorer members of society receive more benefits than richer members?), regional groups (does region X receive more benefits than region Y?), or cultural groups (does clan A benefit more than clan B?) or on gender (do men benefit more than women?). Intergenerational equity issues might also be of concern (how will future generations be affected; will the next generation reap benefits or costs from the project?).

3. *What are the budget and financial sustainability implications of the project?* Does the project stay within budget limitations? What funds will be needed to cover operating expenses? When will funds be required to support the project (outflows) and when can receipts (inflows) be expected? What are the recurrent cost requirements in the future, e.g., for road maintenance, forest management costs? The whole question of cash flow and ability to maintain it is relevant here. Other issues of interest here are regional income and job stability. For example, a recreation project of a highly seasonal nature may involve a great deal of instability in terms of income flows: or a timber harvesting project that does not adequately take into account sustainable timber production over time may have an initial positive impact on incomes and economic activity, but eventually result in hardship and instability as the level of economic activity developed initially can no longer be supported by available timber. (This also relates to the distributional question above.)

4. *How does the project affect foreign exchange balances for the country or region?* This question relates generally to the foreign exchange impacts. In countries with large net outflows, this question is of critical importance, and may influence decisions on foreign exchange expenditures in projects and on subsidies and tariffs.

1.1.2 Economic efficiency questions (going beyond monetary costs and returns)

5. *Does the project involve an economically efficient use of resources?* In other words, do the benefits to the nation, or to the relevant subunit of the nation, exceed the costs of the project, when both are appropriately valued and discounted to a common point in time? If there is some way of making better use of the nations resources, then the answer is "no." We also have to ask: could we eliminate any of the separable components of the project and get higher net benefits; or could we obtain the same benefits with lower cost or with less use of resources? When a main project objective is to increase the aggregate economic benefits (goods and services) derived from the use of the country's limited resources, then the economic efficiency question becomes the central one of concern to public decisionmakers.

1.1.3 Differences between the financial and economic efficiency analyses

In this paper, we use the term *economic* assessment to encompass both *financial* and *economic efficiency* aspects of impact. There are two fundamental differences between *financial* analysis, used to answer the financial questions above, and *economic efficiency* analysis, used to answer the economic efficiency questions. The differences relate to (1) what costs and benefits (or positive and negative impacts) are included in the assessment; and (2) how those costs and benefits (impacts) are valued (see table 1.1 which summarizes the differences by the steps in the analysis process).

The term financial analysis is used to describe the type of analysis that is concerned only with actual monetary flows from (cost) and to (return) specific individuals or groups of individuals within society—farmers, private firms, public corporations, and others. In this sense, financial analysis deals only with those goods and services for which people pay or are paid. It deals with the actual monetary payments involved, e.g., for labor, capital, land. Financial analyses always have to be done from a specific interested party's point of view—government agency, private firm or individual, cooperative, etc.

Table 1.1. Relationship between steps in a financial and an economic efficiency analysis.

Financial Analysis	Economic Efficiency Analysis
1. Identifying and quantifying inputs and outputs	
Direct inputs provided by the financial entity and outputs for which the entity is paid are included.	In addition to direct inputs and outputs, indirect effects are included, i.e., effects which are not included in the financial analysis since they are not bought or sold within the project context. These are effects on others in society.
2. Valuing inputs and outputs	
Market prices are used. For inputs and outputs which occur in the future, future market prices are estimated.	Consumer willingness to pay (w.t.p.) is used as the basic measure of value. In cases where market prices adequately reflect w.t.p., such prices are used. In other cases, "shadow prices" are estimated to provide the best measure of w.t.p.
Inputs and outputs are multiplied by market prices to arrive at total costs and returns which are then entered in the cash flow table. Transfer payments (taxes, subsidies, loan transactions, etc.) are added to the cash flow table.	Inputs and outputs are multiplied by unit economic values to arrive at total economic costs and benefits which are then entered in a total value flow table. Transfer payments are not treated separately, but included as part of economic costs or benefits as appropriate.
3. Comparing costs with benefits	
Using cash flow table, calculate chosen measures of project worth or commercial profitability.	Calculate chosen measures of economic efficiency or economic worth, using the information in the total value flow table.
4. Dealing with uncertainty: Sensitivity analysis	
Test results for uncertainty by varying values of key parameters in a sensitivity analysis.	Test results for uncertainty by varying values of key relationships/parameters in a sensitivity analysis.

Economic efficiency analysis, on the other hand, is concerned with the costs and benefits to society as a whole, regardless of who pays and who gains. It deals with benefits measured in terms of what society actually is willing to pay for goods and services, and costs in terms of the *opportunity costs* involved, e.g., the values of the opportunities foregone when a resource is used for one purpose rather than its next best use that actually would have occurred. This concept is valid regardless of whether or not money actually is paid for a good or service.

The economic efficiency analysis, like the financial analysis, is concerned with profitability, but it is profitability from society's point of view, which is related to the return society as a whole can obtain with a given use of its limited resources. In most cases, teh nation is taken as the unit of society. But it could just as well be a state or smaller unit (part of a nation).

In economic analysis, market prices often are adjusted to more accurately reflect social or economic values. These prices are referred to as *accounting* or *shadow* prices. For example, if there is significant structural unemployment, and a project employs otherwise unemployed laborers, then in the economic efficiency analysis we might apply a labor value lower than the ongoing wage to reflect a lower opportunity cost for such labor that otherwise would be unemployed.

If both financial and economic efficiency questions are being asked, they generally are carried out together since both have much in common in terms of information requirements and procedure. The steps in a financial analysis are more straightforward to carry out and clearer in concept. Therefore, assessments generally start by answering the financial questions related to financial profitability and then the results of this step are used as a starting point for the parallel step in the economic efficiency analysis.

1.2 Need for Question Specificity

Decisionmakers may ask a question without specifying it in enough detail to answer it. In that case, the analyst will have to elicit specification. For example, if the decisionmaker merely asks, what is the financial worth of the project? the analyst will have to ask: financial worth from *whose point of view*, and what is the *measure of financial worth* the decisionmaker wants? Similarly, an economic efficiency analysis can be carried out from the national, the regional, or the local point of view. The point of view needs to be specified, since the information required and the results generated will be different for different points of view.

In the case of income distribution questions, there is a need to be quite specific about which groups are of interest. For example, what do we mean when the question is asked: What are the benefits to low income project interested parties? How shall we define *low income* in the assessment? Some interaction with the decisionmaker is necessary in order to reach agreement on these types of points. In sum, questions have to be specific.

Sometimes decisionmakers will not think of all the relevant financial and economic efficiency questions which need to be answered in order to move ahead constructively with a given project. For example, the decisionmaker may overlook the need to conduct a financial impact analysis from the point of view of potential private participants. Such information is needed in order to make decisions concerning subsidies and charges or fees, and in order to obtain a better understanding of the factors which most likely will influence private participation in the project. If the decisionmaker omits such questions, then it is the analyst's responsibility to make sure that they are considered.

In some cases the analyst may take the initiative in discussing questions early on with the interested parties. The assessment results are more likely to satisfy the interested parties if they have interacted during the early stages in defining the purpose of the assessment.

When proposing that an economic impact assessment be conducted, decisionmakers sometimes neglect to consider the perspectives or questions of all the interested parties involved. The interested parties control resources and must decide whether to commit these resources to a given project and how much to commit. The assessor has to keep this in mind when defining the full array of questions to be dealt with. For example, a project can be extremely attractive from a national economic efficiency point of view, but if it is not also financially attractive to all private entities which have to commit resources to it, then it will not be undertaken as planned. A financially unattractive project can be made financially attractive if the government (the public) provides subsidies (incentives). Whether or not such subsidies are considered justifiable in a social economic context depends directly on their required magnitude in relation to the economic surplus associated with the project (economic benefits minus economic costs, appropriately adjusted to take time into account). Similarly, analyses which show that a project appears to be more attractive financially than economically may provide some indication of the desirability to tax the interested parties involved.

Questions also need to be adjusted to the stage in the project development process. Some of the differences are indicated in table 1.2.

Table 1.2. Questions of relevance at different stages in the project process.[a]

PROJECT PROCESS QUESTIONS DECISION MAKERS ASK (1)	PROJECT IDENTIFICATION (2)	PROJECT PREPARATION (3)	PROJECT APPRAISAL (4)	PROJECT IMPLEMENTATION (5)	PROJECT SUSTAINABILITY (EX POST EVALUATION) (6)
Financial efficiency (overall cash flow) questions	• What is a rough estimate of the monetary returns of the project compared to the monetary outlays or costs involved? • Does the project agency have capability to pay recurrent costs?	• What is the detailed relationship between monetary returns and outlays for the various actors or the interested parties in the project? Will returns likely exceed costs for all those private entities that should be involved in the project? What is the cash flow likely to be (timing of costs and returns)? • What are the financial returns of each alternative considered?	• Does the appraisal team agree with the estimates provided by the project planner? If not, why not? How do the estimates differ? Does the net cash flow meet acceptable criteria for financial acceptability? • Is the alternative chosen the most financially attractive to the interested parties?	• How are actual costs and returns progressing in relation to planned costs and returns? If they differ, why and what can be done about it?	• Were costs and returns as initially expected? (Since they seldom are, the real question is: why did actual costs and returns in the project differ from planned?) What is the ex post financial rate of return compared with the ex ante ROR? Are the financial benefits from the project continuing and can they be sustained?
Questions related to distribution of costs and returns associated with the project (who pays and who gains? what are the foreign exchange impacts)?	• What major groups are likely to gain and which ones are likely to lose?	• Who specifically will pay for the project and who will get benefits from it? What will be the path of costs and benefits over time for different groups? What are the budget implications for different groups?	• Are the distributional implications of the project likely to be as envisioned by the project planners? Are they acceptable in terms of given criteria related to equity and income distribution?	• Who is actually gaining and paying? Are the flows of benefits and costs differing from those envisioned in the plan? If so, why? Should anything be done, and how?	• Who is better off because of the project? Did the project actually reach the target groups? Can the benefits be sustained after the project?
Economic efficiency questions	• What are the likely market and nonmarket benefits and costs involved?	• What are the specific market and nonmarket benefits and costs involved in this project and what is the likely flow of such benefits and costs over time? • What are the economic returns for each alternative considered?	• Does the appraisal team agree with the estimates of costs and benefits and the analysis provided by the project planners? If not, how do they differ? • Was the alternative chosen the most economically attractive?	• How are actual economic costs and benefits progressing in relation to planned ones? Included here is monitoring and assessment of project externalities.	• Were the actual costs and benefits of the project in line with the planned ones? If not, why did they differ? What is the ex post economic rate of return in relation to the ex ante rate provided by the project plan? Are the economic benefits from the project sustainable over time?

[a]These should include the main questions of interest to all those groups involved in the project.

2
Designing the Assessment Approach

One could go about answering the various questions of interest put forth in chapter 1 in a number of different ways. Before deciding on the specific method to use it is important to design the overall approach that will be used in the economic assessment (which likely will include answering a number of questions). This includes considering

- the common principles and processes for addressing different questions, and
- the constraints on the overall assessment.

The first consideration can help make the overall assessment more effective and efficient by avoiding unnecessary duplication of efforts as each question is addressed. The second consideration is important so that resources can be allocated properly to each of the questions which needs to be answered and so that timing of efforts can be adjusted to reflect needs and resource constraints.

Even though the questions discussed in the previous section are quite different in terms of answers and empirical methods for answering them, each one of them should be addressed or analyzed using a common economic analysis *process* or set of steps, keeping in mind certain *basic principles* which apply regardless of which question is being answered.

2.1 Using the *With and Without* Principle

A project impact can be defined as the difference with and without the project. This with and without concept is basic to project analysis. It is important to keep in mind that the situation as it exists today would likely not remain the same in the absence of the project. Thus, the *before project* situation should not be taken to be the same as the *without project* situation when identifying project effects. Changes would likely take place without the project and these need to be estimated (see box 2.1).

When substantial change is not expected without the project during the period of the project, the analyst may be justified in saving time and money by assuming the before project situation would have held constant over time. However, there are many forestry projects—which generally involve long time periods—where ignoring potential changes over time without the project will involve some major under- or overestimation of costs and benefits.

In applying the with and without concept to economic costs (or *opportunity costs*), particular care has to be taken to identify properly the best *actual* opportunity foregone, i.e., the best alternative use of an input that actually would have taken place without the project, taking into account the various institutional (social and political) constraints or policies that are expected to exist (see box 2.2). One of the classic guides to economic assessment, the *UNIDO Guidelines*, makes this point as follows:

> "The technical opportunities that cannot be made use of, given social constraints, are not real opportunities, and the identification of costs as maximum benefits

sacrificed must be based on real feasibility.... The starting point of all project evaluation is to ask the question: If we did not choose the project, what difference would it make? And the assessment of the differences that would result depends on a clear identification of political and social constraints that limit economic opportunities" (UNIDO 1972).

Box 2.1. Applying the with and without principle.

In a soil conservation project to restore fertility to a moderately eroded piece of land and to prevent further loss of fertility, the benefit is sometimes estimated as the difference between production with the present level of moderate fertility and production which will be achieved with the improved fertility associated with the project. However, assume that if the conservation project were not introduced, the situation without the project would deteriorate to one of total loss of production, due to the cumulative nature of the erosion process. The correct benefit measure in this case would include the difference between a gradual [illegible] production and the increased level achieved with the project. (The timing of the deterioration process without the project would have to be considered in deriving the output quantities to use.) It would not be the difference between the present moderate level of production and the improved production with the project. If the analyst ignored the with and without concept, the benefits due to the project would be understated. This same undercounting can occur with any type of forestry and conservation project where loss avoidance is an objective.

2.2 Considering Interdependence and Separability of Project Components

Most projects consist of interrelated components. In terms of costs and benefits, these components will either be interdependent or separable. Some components of a project can be defined separately in the sense that most of their costs and benefits are independent from the rest of the project and the components can be added to (eliminated from) the project without affecting its overall feasibility, although they may obviously affect its overall profitability or economic efficiency.

For example, consider a watershed management project that has agroforestry, soil conservation, agriculture and farmer organization components. If the inputs and outputs of one or more of these components can reasonably be separated from the inputs and outputs of the other components, then they should be analyzed separately in terms of impacts.

For any project and purpose the question is: Does it make sense to separate components in the context of the purpose for the analysis, i.e., in terms of the questions being asked?

The answer depends very much on the viewpoint of the institution for which the analysis is being carried out and on the questions being asked. However, in general if major separable components and their costs and benefits can be identified, then they should be analyzed separately, since each separable project component should have benefits at least equal to costs in order for the total project to be considered an economically efficient use of resources.

Box 2.2. Example of opportunity cost in a policy context.

Assume that an area of currently idle land technically could be used for two mutually exclusive purposes: agriculture or a forest plantation. The plantation alternative would yield $150 of benefits per year net of all costs except land cost. The agricultural alternative would generate a benefit of $200 per year net of all costs except land. There is, however, a policy restriction: the government has on various considerations decided that only forestry will be allowed in the area.

The analyst is asked to estimate the economic worth of the plantation alternative. To do this, he will need to estimate, among other things, the value of the land that will be used by the project. This value is equivalent to the net benefits given up by not being able to undertake the best alternative use for the land. Since the main *technically* feasible alternative is agriculture, with a net benefit of $200 annually, some would argue that this is the value of land which should be entered as the opportunity cost in the economic analysis of the afforestation project.

Others would say that, since a policy decision has ruled out the agricultural alternative, the relevant value of land for the afforestation project should be equal to the net benefits foregone by not undertaking the next best *forestry* alternative. If this next best forestry alternative generates a net benefit of $60 per year, again exclusive of land cost, which value should be entered in the analysis, $200 or $60?

Depending on which value is chosen, two radically different estimates of project worth might occur. As mentioned, the plantation would yield net benefits of $150, excluding consideration of land opportunity cost. If $200 is taken as the economic value of land, the economic worth of the plantation project would be equal to $150 - $200, or -$50, and the economic analyst would recommend against implementation on the grounds that costs outweigh benefits. On the other hand, if the policy restriction is taken into account, the net benefit generated by the afforestation project would be $150 - $60 = $90, and the project would have the chance to be approved since its worth is positive. Which approach is the correct one?

Using the traditional "with and without" principle, the analyst should consider only the estimated *actual* difference. The restrictive policy imposes real boundaries to feasible opportunities, as real as those imposed by technological constraints. Therefore, the value of the potential agricultural output should not enter the analysis of the plantation project. Failure to observe this principle would lead to the wrong decisions. In the example, if the policy restriction is considered as irrelevant, there would be no economic argument for approving the afforestation project. The project would not be implemented, but neither would the superior agricultural option, for the policy is in fact real. In consequence, society would receive neither the benefits of afforestation nor the benefits of the agricultural option.

As an aside it should be noted that the cost to society of maintaining the policy is $50—the amount given up by society.

The answer also depends to some extent on the stage in the project planning process. At the early stages, when alternative combinations of components and project sizes are being explored, it makes sense to separate out components and to analyze them individually and in combinations. This is indeed one of the main functions of the project identification and preparation stages in the planning process, and one of the main uses for economic analysis at these stages. However, once a project alternative has been shaped and designed in detail, it may make little sense to spend much time on detailed analysis of components that already have been analyzed and accepted in the earlier stages of planning.

2.3. Considering Constraints on the Assessment

The assessment should not only be effective, that is, provide appropriate answers to the questions being asked, but also be realistic in its approach, in recognizing the practical constraints under which the assessment is being conducted. Consideration of these constraints will help the analyst plan and organize the assessment. Figure 2.1 indicates the considerations that should be taken into account.

1. *Technical considerations.* Technical considerations include: data requirements and data availability; cost; time requirements; and reliability, reproducibility, and acceptance in the scientific community. Different assessment questions require different kinds of data. For example, an assessment that includes an analysis of the distribution of costs and benefits would require considerably more detailed data and information than one that considers only aggregate impacts. Such a distributional analysis also is likely to require considerably more time to obtain and process the required input data, and to actually carry out the analysis, than would be required for an aggregate analysis. Some methods of analysis may be more reliable than others, and be more easily reproduced by other analysts. This may or may not lead to greater acceptance in the scientific community. For example, assessments based on observed and reported market values may be more easily reproduced by other analysts than assessments which involve unique estimates to account for nonmarket values, and thus be more readily accepted by the scientific community. Yet, some segments of the scientific community may give greater credence to attempts to account for nonmarket values that are known to exist, even though the methods of accounting for those values are not as widely accepted.

2. *Decisionmaker/user considerations.* The actual purposes and importance of the assessment in decisionmaking are primary considerations which should dictate how an assessment is designed and organized to give it maximum usefulness (make it timely and relevant for the intended use and purpose).

   Time and skills are important constraints in designing assessments in most developing countries. It takes time and appropriate skills to plan an assessment, to collect, process, analyze, and synthesize data and information used in an assessment, and to write up the report on the analysis, have it reviewed, and disseminate it to potential users. The amount of time available in which to conduct an assessment must be carefully considered in deciding which questions can be answered, and in the choice of methods by which the questions are to be answered. If the time necessary to complete all of the tasks on the assessment is longer than the time framework initially set by the decisionmaker, some adjustments will have to be made. Perhaps the time frame can be lengthened, or more personnel obtained, or some of the questions modified, or assessment methods changed. Again, this must be an interactive and iterative decision process between decisionmakers and analysts.

   An important constraint in conducting any assessment is the amount of funding, skills and time available. In proposing an assessment, decisionmakers may have a preliminary total budget for the assessment in mind. But until the questions to be answered by the assessment are clearly specified in operational terms, the costs of the assessment cannot be estimated. Once the questions are specified, it is up to the analysts to determine what it would cost to answer these questions. If the cost of conducting the assessment is within the proposed budget, the decisionmaker may decide to go ahead with it. However, if the cost of the proposed assessment exceeds the proposed budget, a decision will have to be made as to whether the budget will be increased to cover the costs, or some of the questions to be answered will be eliminated or modified. Or, it may be possible to modify the assessment approach to use a less costly method to provide more general answers that are not as precise.

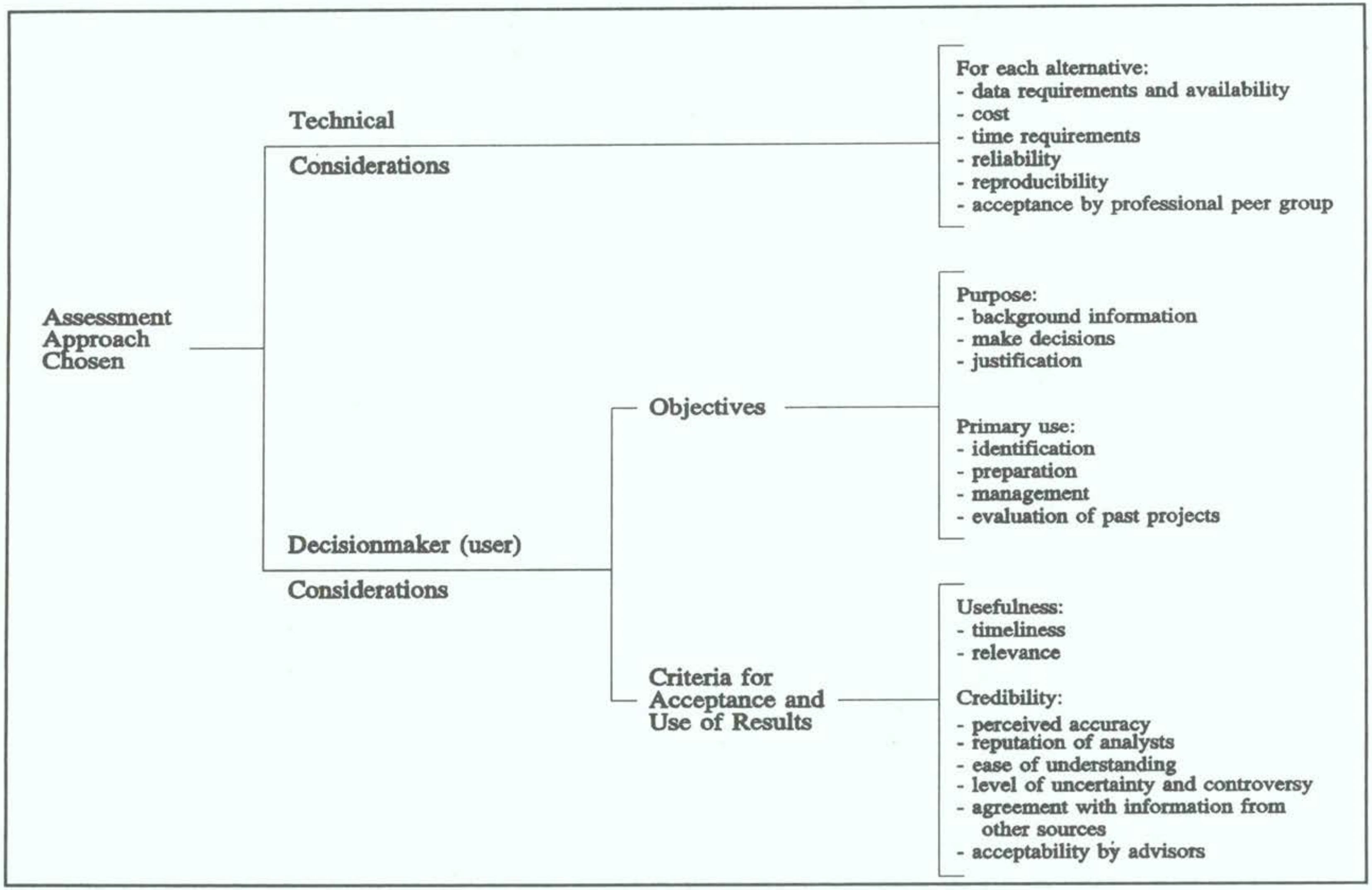

Figure 2.1. Constraints affecting the assessment approach chosen.

Fitting assessment to budget and vice versa is one of the needs which argues for an interactive process between decisionmakers and analysts.

Finally, there is the question of credibility of the assessment and the assessor to be considered. This depends on: the reputation of the assessor (something which is built up over time); the ease with which the assessment process and results can be understood; the way in which uncertainty is handled (the transparency of the assessment); the extent to which the assessor draws on results of parallel assessments and indicates similarities and differences; and the acceptability of the results by decisionmaker advisors and technical personnel, which depends to a great extent on all the other items mentioned above.

2.4 The Basic Assessment Steps

The process described below is a basic one that can be used in answering both financial and economic efficiency questions, regardless of the stage in the project development process, and regardless of the number of iterations at each stage. The differences in how the process is used at different stages in the project cycle relate to the purpose of the assessment, the assessment question to be answered, the sophistication of the estimating techniques used, the amounts of data required and collected, and the level of detail considered and time devoted to the analysis.

Step 1. Identifying and quantifying inputs and outputs

For any question being addressed, the first step in the analysis process is to identify physical inputs and outputs; what goods and services go into the project and what goods and services are produced by the project. This identification should be done for each of the separable components being considered in the assessment. Preparation of a table which clearly indicates the physical flows of inputs and outputs (see table 2.1) facilitates the assessment process. In answering the financial questions, only market priced inputs (those involving a financial outlay by the interested parties) and market priced outputs (those involving financial income or returns to the interested parties) are included. For example: market priced inputs may include project personnel person/days, vehicles, gallons of gas, equipment or, seedlings; market priced outputs may include poles, crop yields, or bales of fodder.

In answering the economic efficiency questions, nonmarket inputs and outputs should be considered in addition to the market priced inputs and outputs. Nonmarket inputs and outputs are those associated with (used in [produced by]) the project, but which the project does not buy or sell. These are external to the project in a financial sense since they involve no direct monetary inflows or outflows. For example: nonmarket inputs might be volunteered labor, subsidized water, or donated land. Nonmarket project outputs might include; free fuelwood, offsite erosion control, water pollution (negative output), or enhanced carbon storage.

Table 2.1. Physical flows of project inputs and outputs.

Item	Units	Years					
		0	1	2	3-10	10-15	t
INPUTS							
Component A: input 1 input 2 : input n							
Component B: input 1 input 2 : input n							
OUTPUTS							
Component A: output 1 output 2 : output n							
Component B: output 1 output 2 : output n							

Step 2. Valuing inputs and outputs

The next step in answering both the financial and the economic efficiency questions is to develop unit value tables for the inputs and outputs with due consideration given to trends in prices and forecasts or projections of future prices. When market prices have been identified for the financial analysis, a large overlap will likely exist with the economic analysis, i.e., most of the input and output items included in the financial analysis will also be represented by similar ones in the economic accounts.

However, market prices may not adequately reflect social costs or benefits associated with the project, or the opportunities foregone by the project's uses of resources. There can thus be differences in the values attached to such common inputs and outputs and these have to be considered in deriving the economic unit value tables. Unit values used in the financial analysis are market prices. In the economic analysis, inputs and outputs are valued on the basis of consumers' true *willingness to pay* (w.t.p.) for them. Market prices may or may not adequately reflect w.t.p. If they do not do so, then *shadow prices* must be developed.[1]

[1]Put simply, shadow prices are *estimates* of people's actual w.t.p. for goods and services, whether they are market or nonmarket goods and services.

Derivation of unit values for the economic efficiency analysis involves a two stage process. First, for inputs and outputs traded in a market, a judgement is made on the adequacy of market prices used in the financial analysis as measures of economic value. If they are judged to be adequate, they are entered in a table showing unit economic values. If they are judged to be inadequate, then they are treated in the second stage just like indirect effects for which no market prices exist.

This second stage involves a judgement on whether or not an acceptable shadow price can be developed for all the inputs and outputs (market and nonmarket) considered in the economic efficiency analysis. If the judgement is negative, then it is better to treat the effect in a qualitative or physical quantitative fashion, by making explicit mention of the effect in the economic analysis report and referring to the financial value. The analyst should not try to develop a spurious value measure which will merely serve to confuse and mislead decisionmakers. If the judgement is that a shadow price can be developed, then the analyst proceeds to do so and the resulting values are entered in the unit value table.

Step 3. Conducting the analysis (answering the questions, given the value information derived in the previous step).

This third step involves comparing costs and benefits in various ways to answer the relevant financial and economic efficiency questions. Two common measures for looking at financial and economic efficiency are the net present worth (all discounted benefits minus all discounted costs) and the internal rate of return (the discount rate that makes all discounted benefits equal to all discounted costs or the net present value [NPV] equal to zero). These measures are used for both economic and financial analyses. The analyst also can choose to conduct a different analysis from the different interested parties' perspectives. For example, the value flow table might include costs and benefits that are accrued to participating farmers as well as to the overall project. The analyst could separate out those costs and benefits specific to each group, and conduct an analysis to determine how the project impacts the interested parties from their own perspective. The same could be done for foreign exchange and local currency expenditures.

Step 4. Dealing with uncertainty: Sensitivity analysis

Uncertainty is an inherent companion of projections and ex ante assessments. Accurately or precisely identifying, valuing, and comparing costs and benefits is always a problem. Future costs and benefits cannot be measured, but only estimated. Thus a degree of uncertainty surrounds every estimated value. Information is nearly always limited and of limited quality. For this reason, a major function of economic analysis is to test the sensitivity of selected measures of project worth to changes in assumptions concerning inputs and outputs and the values attached to them (a sensitivity analysis). Such information can be extremely useful for decisionmakers.

3
Answering the Financial and Economic Efficiency Questions

After deciding upon the question(s) to be answered by the assessment, and after developing the assessment approach to be followed, the analyst can start to answer the questions. The first step is to determine the actual method that will be used to answer each question. The purpose of this chapter is to assist the analyst in choosing a method to answer the assessment questions. Part II deals with techniques. The overall framework for answering the questions is illustrated in figure 3.1.

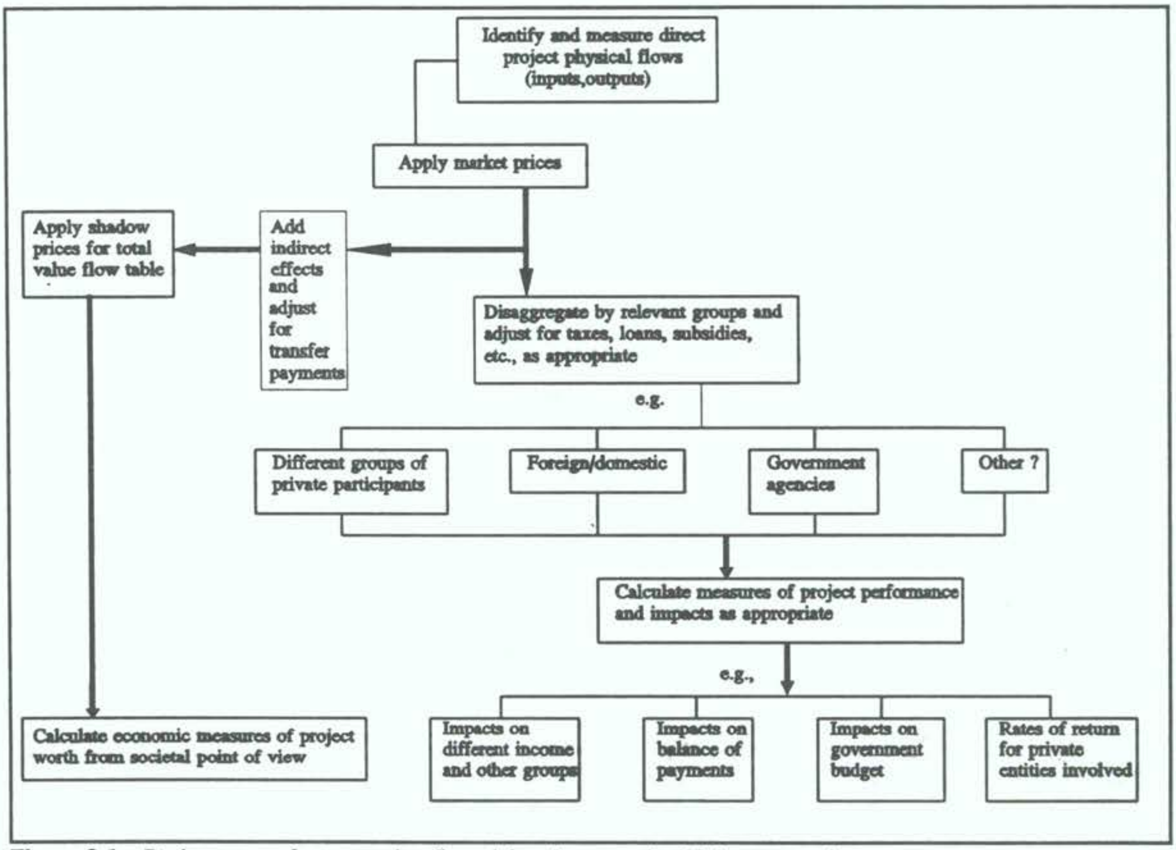

Figure 3.1. Basic process for answering financial and economic efficiency questions.

3.1 Methods for Answering Financial Questions

Each of the different financial questions discussed in chapter 1 can be asked at different stages in the project process. Differences in how each question is answered will relate to the estimating techniques used, the quality and amounts of data required, the level of detail considered, and time devoted to the analysis. When conducting an assessment, project information generally is presented in a set of *interrelated working tables.* Some basic project information will be required regardless of which financial question is being answered, and will be required also in the economic efficiency analysis. This information includes project physical flows of inputs and outputs and the market prices associated with those inputs and outputs. Additional information and tables will be required depending upon the question being answered.

An example will be used to illustrate the overall approach to answering the financial and economic efficiency questions.[2] It involves a hypothetical project in which about 200 private farmers plant trees on a total of some 2000 ha of their own, marginal farm land. The government is sponsoring the project by providing technical assistance, cash subsidies for planting, and the planting stock. From the government's point of view, the total planting program is duly treated as a *project*.

3.1.1. Is the project financially acceptable to the interested parties?

Financial *acceptability* can be different things for different interested parties. Conventionally, financial *attractiveness* is determined when the following three criteria have been met:

1. the value of aggregate benefits is greater than the value of the aggregate costs when both are appropriately discounted with the alternative rate of return (ARR),[3] i.e., the net present value (NPV) of the project is greater than zero;[4]
2. the discounted value of benefits is at least equal to the value of costs for each separable project component; and
3. there is no lower cost means available for achieving project objectives.

The same analytical method is used to answer the question about financial acceptability regardless of when in the project process the assessment is conducted. Generally, only the type and quality of the information used in the analysis, and the number and types of interested parties might differ from one project stage to another. For example: if asking this question during the project identification stage of a proposed farm forestry project, the analyst must use crop and tree yield and price estimates from whatever sources seem to fairly represent the proposed project area, and must make rough estimates of the number of participating farmers and the rate at which they will adopt the proposed techniques. If asking this question during the evaluation stage, then the analyst will use actual yield, price and adoption rate data from the project.

The *first* step is to identify the interested parties, or the entities which will or do have a financial stake in the project. The nature of the interested parties is highly dependent upon the type of project, they might include farmers, community organizations, financial institutions and various enterprises. Following the analysis process outlined in chapter 2, in the *second* step, the analyst identifies project components which impact the various interested parties, and the physical inputs and outputs related to those components. The *third* step is to estimate or obtain market prices

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[2]Based on OECD, 1986.

[3]ARR, the rate of return private parties could get in the best alternative use of their resources.

[4]As mentioned in text, techniques and terms are discussed in Part II.

for the inputs and outputs. In the *fourth* step, market prices are used to estimate cash flows for each interested party group; and various measures (NPV, financial rate of return [FRR], etc.) are calculated to indicate financial incentive for the interested parties' participation (see chapter 6 and annexes). The interested parties' ARR would be compared with the FRR for the project alternative. A major assumption is that if the NPVs or FRRs are high enough, then private investors will participate, ensuring feasibility for the project component particular to the interested parties. Public uses for information on private interested parties' FRRs are indicated in box 3.1.

Box 3.1. Public use of finance information on private interested parties.

If calculated FRRs for certain groups are below assumed private alternative rates of return, then this information could provide a basis for upward adjustment of subsidies or public financial input into the project or modifications in laws and regulations. If higher subsidies cannot be justified, then a lower than acceptable FRR will indicate that risk capital is not likely to be invested in the project. The project will either have to be redesigned or rejected in terms of this dimension of feasibility. If calculated FRRs for some groups are considerably above maximum needed rates of return, then this may indicate the possibility of downward adjustment in subsidy levels or increases in taxes, depending upon what other objectives (e.g., related to income redistribution) are relevant in terms of the group(s) considered. See chapter 6 for instruction on how to calculate financial rates of return and net present value.

In the example used in this chapter, the question of financial attractiveness can be determined by first identifying physical inputs and outputs to the interested parties—aggregated for private landowners and for the forest agency (tables 3.1 and 3.2). The contents of these two tables are summed to generate a single table displaying aggregate project inputs and outputs (table 3.3). A table of market prices and forest agency expenses permit the calculation of cash flow tables for the total project, or for each of the interested party groups. Table 3.6, based on tables 3.2 and 3.4, represents estimated cash flows to the participating farmers. This table, together with an estimate of relevant alternative rates of return for the private participants involved, provides the necessary information for answering the financial attractiveness question for the farmers in aggregate. The assessor may also look at variability within the group.

Table 3.1. Forest agency—inputs and outputs.

Item	Units[a]	Years				
		0	1	2	3-14[b]	15
Inputs						
Supervision	m.-d./year	40	30	10	10	10
Extension help	m.-d./year	400	100	100	40	200
Seedlings[c]	1,000 seedlings/year	2,000	–	–	–	–
Vehicles	Vehicles days/year	440	130	110	50	210
Outputs		None to public sector				

[a] m.-d. = man days
[b] Items in this column are *per year* during period shown.
[c] Seedlings are given to landowners by the Agency.

Table 3.2. Private landowners—inputs and outputs.

Item	Units[a]	Years				
		0	1	2	3-14[b]	15
Inputs						
Labor	1,000 m.-d./year	10	4	4	2	2
Tractors	Machine-days/year	2,000	30	30	10	10
Lands	HA.	2,000	2,000	2,000	2,000	2,000
Outputs						
Pulpwood	1,000 m^3/year					320
Firewood	1,000 m^3/year				10	

[a] m.-d. = man days.
[b] Items in this column are *per year* during the period shown.

Table 3.3. Project physical inputs and outputs.

Item	Units[a]	Years				
		0	1	2	3-14[b]	15
Inputs						
Unskilled labor	1,000 m.-d./year	4	2	2	1	1
Semiskilled labor	1,000 m.-d./year	4	1	1	1	1
Skilled labor	1,000 m.-d./year	2	1	1	-	-
Supervision	m.-d./year	40	30	10	10	10
Extension	m.-d./year	400	100	100	40	200
Tractors	Machine days/year	2,000	30	30	10	10
Trucks	Vehicle days/year	440	130	110	50	210
Land[c]	Ha.	2,000	2,000	2,000	2,000	2,000
Seedlings	1/000 seedlings/year	2,000				
Outputs						
Pulpwood	1,000 m^3/year					320
Firewood	1,000 m^3/year				10	

[a] m.-d. = man days.
[b] Items in this column are *per year* during period shown.
[c] It is assumed that the same land is used every year.

Table 3.4. Estimated market prices.[a]

Item	Units	Price
Inputs		
Unskilled labor	\$/m.d.	20
Semiskilled labor	\$/m.d.	30
Skilled labor	\$/m.d.	40
Professional	\$/m.d.	60
Tractors	\$/machine day	200[b]
Trucks	\$/vehicle day	40[b]
Land	\$/ha. year	10[c]
Seedlings	\$/1,000 seedlings	50
Outputs		
Pulpwood	$\$/m^3$	20[d]
Firewood	$\$/m^3$	10

[a] In real terms, i.e., in fixed dollars per unit (e.g., 1990 dollars) of different times are involved.
[b] Including operating cost. Price of equipment based on import value.
[c] Entered as rental cost.
[d] Based on FOB price, adjusted to take into account transport and handling costs from forest.

Table 3.5. Forest agency outlays.[a] (\$1,000/year)

Item	Years				
	0	1	2	3-14	15
Costs					
Supervision	2.4	1.8	0.6	0.6	0.6
Extension	24	6.0	6.0	2.4	12
Seedlings	100	–	–	–	–
Vehicles	17.6	5.2	4.4	2.0	8.4
Total cost	144	13	11	5	21

Source: Tables 3.1 and 3.4.
[a] This table could also include *increased* tax returns to government due to the project. In that case, it would detail total government outlays/inflows, and not merely forest agency consideration.

Table 3.6. Cash flow table for private landowners ($1,000/year).

Item	Years				
	0	1	2	3-14	15
Revenues (receipts)					
1. Sale of products				100	6,400
2. Subsidy[a]					
Subtotal				100	6,400
Cost (expenditures)					
3. Labor	280	110	110	50	50
4. Tractors	400	6	6	2	2
5. Land rent	20	20	20	20	20
Subtotal	700	136	136	72	72
Net revenue (cost)	(700)	(136)	(136)	28	6,328

Source: Tables 3.2 and 3.4.
[a] Space for entry of subsidy figures, if one wants to study the consequences.

3.1.2. What are the income distribution impacts?

Again, the approach to answering this question will be much the same regardless of the stage in the project process at which the analyst is conducting the assessment. Information characteristics and the nature of the groups of interest may vary. Income distribution is a topic of interest in both economic and social impact assessments, and thus coordination between economists and social scientists in formulating the parameters of the response to this question is beneficial. Most often the question relates to how costs and benefits associated with a given project alternative affect different income groups, i.e., do poorer persons gain more than richer persons. Distribution of costs and benefits across regions or even generations might be of interest. The types of tables calculated for answering the previous question can also be used.

There is no single acceptable measure of the effect of the project on income redistribution. In other words, it is not possible to put forward one measure for income distribution impacts that can be used to judge whether the project is acceptable or unacceptable in terms of this question. Rather, the decisionmaker must be presented with estimates of positive and negative impacts on different income groups over the life of the project.

In the example, table 3.8, derived from tables 3.4 and 3.7, provides the necessary information to answer the question regarding employment impacts by income groups. The project generated additional employment in the area, and this employment impacts different income groups to varying degrees. In some cases, the table itself is all that is needed. In other cases, the information could be presented in comparative form, in a table or graph showing relative impacts of different project design. The NPV of each schedule of additional income could also be calculated for each group.

Table 3.7. Additional direct employment by income groups (man days/year[a]).

Income groups	Years				
	0	1	2	3-14	15
$0 - 4,000	4,000	2,000	2,000	1,000	1,000
$4,000 - 6,000	4,000	1,000	1,000	1,000	1,000
$6,000 - 15,000	2,000	1,000	1,000	-	-
$15,000 +	440	130	110	50	210

[a] Similar tables could be prepared showing indirect employment effects.

Table 3.8. Additional income by income groups ($1,000/year).

Income groups	Wage rate $/m.d.	Years				
		0	1	2	3-14	15
0 - 4,000	20	80	40	40	20	20
4,000 - 6,000	30	120	30	30	30	30
6,000 - 15,000	40	80	40	40	-	-
15,000 +	60	26.4	7.8	6.6	3.0	12.6

Source: Tables 3.7 and 3.4.
Note: Supplementary tables could be used to show the average rate changes due to project.

3.1.3. What are the budget and financial sustainability implications?

Simple accounting of the flows of public funds and the receipts by the government provide the best information that can be used to answer this question. A financial rate of return (FRR) for the public sector (or the responsible agencies) could be calculated—but, in most cases, financial rates of return provide little guidance concerning desirability of public projects. There is no single measure that can be calculated to answer this question. If an agency has budget guidelines set at the project level, then the information provided by a table showing the required financial contributions for the agency over time can be used to see if the project can be realized within existing budgets (see table 3.5).

Decisionmakers have to decide whether or not the proposed budget for the project is acceptable and how the project compares with other possible uses of agency funds. If the proposed project budget is too large, then the project can be redesigned on a smaller scale, or if that is not possible, it can be rejected as being not feasible under existing budget constraints.

When considering either providing or accepting funds for new projects, decisionmakers must also consider the critically important issue of recurrent costs of the project and the ability of the implementing agency to support those costs once outside project funding is halted. The benefits of many projects have failed to continue beyond project termination because the local capacity to pay those costs was not considered during planning, or developed during the project period.

Other stability impacts may also be of interest such as, effects on the pattern of jobs and employment over time, or the minimum rate and periodicity of income to different groups. This is an assessment topic where economic and social analyses overlap. It is an area in which there should be coordination of the project appraisal process to avoid duplication, but also to insure that relevant impacts are covered.

3.1.4. How will the project affect foreign exchange inflows and outflows?

If the analyst is answering this question in terms of whether or not the project uses more foreign exchange than it brings into the country or saves for the country through import substitution, s/he must identify all project inputs or outputs which are either imported, substitute for traditional imports, or are exported. The value of these commodities must also be determined at the FOB or CIF prices and in their respective currencies. The *black market* exchange rates should also be taken into account. The main problem in answering the question is whether or not secondary foreign exchange effects should be included, i.e., the foreign exchange effects which are caused by the project, but not directly accounted for by imports of project inputs; by exports of project outputs; or by substitution of output for imports. For example, a given project may have a positive effect on foreign exchange earnings in direct terms, but may result in large increases in imports in other sectors.

Assume a plantation project that will produce wood for an intended expansion of domestic pulp and paper production and some wood for export. There are no imported inputs and some foreign exchange earnings through wood exports. Looked at in isolation, the plantation project has a positive impact on foreign exchange earnings. But assume that the pulp mill expansion involves large imports of foreign equipment and expertise. In this case, the secondary effects of the overall activity (plantation and mill) may have a negative effect. The question is: how far do we go in estimating the total effects of the project? The answer is that it depends on the situation in the country in question and the extent to which foreign exchange impacts is a critical consideration for decisionmakers.

In the example, table 3.10, derived from tables 3.4 and 3.9, provides the relevant information to answer the question. The table provides an indication of the net foreign exchange impact of the project alternative over time. What is judged to be acceptable depends on the particular circumstances.

No single measure can be recommended for measuring foreign exchange impacts. The simplest approach is to prepare a table showing the direct net inflows (outflows) of foreign exchange associated with the project over time (see table 3.10). A further step may be to discount the flows over time to provide a net present value of the effect. These types of tables include only the primary effects. Additional tables can be prepared showing estimated secondary effects, if appropriate multipliers[5] are available. Such multipliers can be crudely estimated from previous experience, or they can be derived from input-output tables, if such are available for the country and/or region in question.

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[5]Of the secondary activity generated per unit of primary activity.

Table 3.9. Imported inputs and exported outputs at different times.

	Units	Time (years)	Volume
Imported inputs			
Trucks	Trucks/year	0	3
Tractors	Tractors/year	0	3
Exports			
Pulpwood	1,000 m^3/year	15	320

[a] Import substitutes would also be included in this table.

Table 3.10. Balance of payments effects ($1,000/year).

Item	Time (year)	Foreign exchange	
		Outflow	Inflow
Tractors	0	120	
Trucks	0	45	
Pulpwood	15		3,200

Source: Tables 3.4 and 3.9.
Note: The inflow and outflow values could be discounted back to the present, using the social discount rate. This would provide a measure of the present value of direct net foreign exchange effect.

3.2 Methods for Answering Economic Efficiency Questions

As stated earlier, economic efficiency analysis is needed to provide information on whether or not a project would provide an efficient use of the resources available to society as a whole. Three separate conditions reflect economic efficiency and these conditions can be treated as separate assessment questions. Put simply (as in the case of financial attractiveness), the relevant questions would be

1. Is the value of aggregate benefits greater than the value of the aggregate costs?
2. Is the value of benefits at least equal to the value of costs for each separable project component?
3. Is there any lower cost means available for achieving project objectives?

In all three cases, costs and benefits over time have been appropriately discounted to a common point in time, using the ARR as the discount rate.

The first step in answering any of the questions would be to identify which separable project components to include in the assessment, and the physical inputs and outputs related to those components. These inputs and outputs might be the same as those used in a financial analysis, or the analyst might choose to include new inputs or outputs which have economic but not financial value, since they are not traded in markets. The next step would be to generate a *value flow* table. This table differs from the *cash flow* table used to answer the financial questions in that it represents costs and benefits to society rather than to separate the interested parties. To shift from a cash flow table to a value flow table, three types of adjustment need to be made

1. estimate values of the added inputs and outputs that are not included in the financial analyses;
2. revalue some costs and benefits that are included in the cash flow table;
3. remove transfer payments such as taxes, subsidies, and loans from the cash flow table and adjust for differences in timing of economic and financial costs and economic benefits and financial returns.

Two measures are commonly calculated to assist in answering the economic efficiency questions: the NPV and the economic rate of return (ERR). In comparing mutually exclusive alternatives, the appropriate measure of comparison is the NPV. For ranking projects in a situation where a limited budget is to be allocated among not-mutually exclusive alternatives (i.e., capital budgeting), an appropriate ranking measure is the ERR. Chapter 6 describes both of these measures and compares them in more technical terms. Since in most cases decisionmakers are concerned both with the best design for a given project (mutually exclusive alternatives to achieve a given project objective) and with the problem of allocation of a limited budget to a number of projects, both measures should generally be calculated.

If the present value of project benefits exceeds the present value of costs, the project will have a positive NPV. If, in this case, the appropriate social discount rate is used to calculate present values, the project will also have an ERR that exceeds the social discount rate. Thus, either measure can be used to answer the economic efficiency question, both for the total project and its separable components.

In the forestry project example, table 3.12, derived from information in tables 3.4 and 3.11, provides the necessary information for calculating both the NPV and the ERR. The calculation techniques are straightforward.[6]

The final question related to economic efficiency is whether or not there any lower cost means available for achieving project objectives? The first step in answering this question would be to identify the physical inputs and outputs (both direct and indirect) for each alternative project approach which yielded the desired outputs. Value flows for each alternative would be generated and the sum and NPV of aggregate costs calculated. This question might be used if decisionmakers have already decided to do a project, or if calculation of project benefits was not feasible, and the analyst is asked only to determine the least cost means to accomplish project objectives.

[6]For details, see chapter 6.

Table 3.11. Economic prices.[a]

Item	Units	Economic price
Inputs		
Unskilled labor	S/m.d.	15
Semiskilled labor	$/m.d.	30
Skilled labor	$/m.d.	40
Professional	$/m.d.	60
Tractors	$/machine day	200
Trucks	$/vehicle day	40
Land	$/ha.year	10
Seedlings	$/1,000 seedlings	50
Outputs		
Pulpwood	$/m^3	20
Firewood	$/m^3	10

[a] Since only unskilled labor has a shadow price different from market traded price in our example, and since no nonmarket traded inputs and outputs were identified, table 3.12 could have been eliminated. We have included it here for the sake of clarity.

Table 3.12. Total economic value flow table ($1,000/year[a]).

Item	Years				
	0	1	2	3-14	15
Costs					
Unskilled labor	60	30	30	15	15
Semiskilled labor	120	30	30	30	30
Skilled labor	80	40	40	–	–
Supervision	2.4	1.8	0.6	0.6	0.6
Extension	24.0	6.0	6.0	2.4	12.0
Tractors	400	6.0	6.0	2.0	2.0
Trucks	17.6	5.2	4.4	2.0	8.4
Land	20.0	20.0	20.0	20.0	20.0
Seedlings	100	–	–	–	–
Total	824	139	137	72	88
Benefits					
Pulpwood					6,400.0
Firewood				100.0	
Total				100.0	6,400.0
Net benefits (costs)	(824)	(139)	(137)	28	6,312

Source: Tables 3.4 and 3.11.
[a] In real terms, e.g., fixed 1980 dollars.

PART II

Principles and Techniques for Conducting Economic Analyses

Part II contains a more technical discussion of the principles and techniques of economic analysis that can be used in developing the measures of value and project worth illustrated in the previous chapter (see figure II.1). One chapter is devoted to each of the four main steps in the analysis process. Thus, chapter 4 deals with identification and specification of inputs and outputs. Chapter 5 deals with valuation of inputs and outputs. Chapter 6 deals with the analysis itself, i.e., how costs and benefits are compared to develop measures that can be used in answering the questions being addressed in the assessment. Chapter 7 deals with the treatment of uncertainty, i.e., how the analyst can produce information that will be useful to the decisionmaker in judging the relative merits of alternatives, taking uncertainty into account.

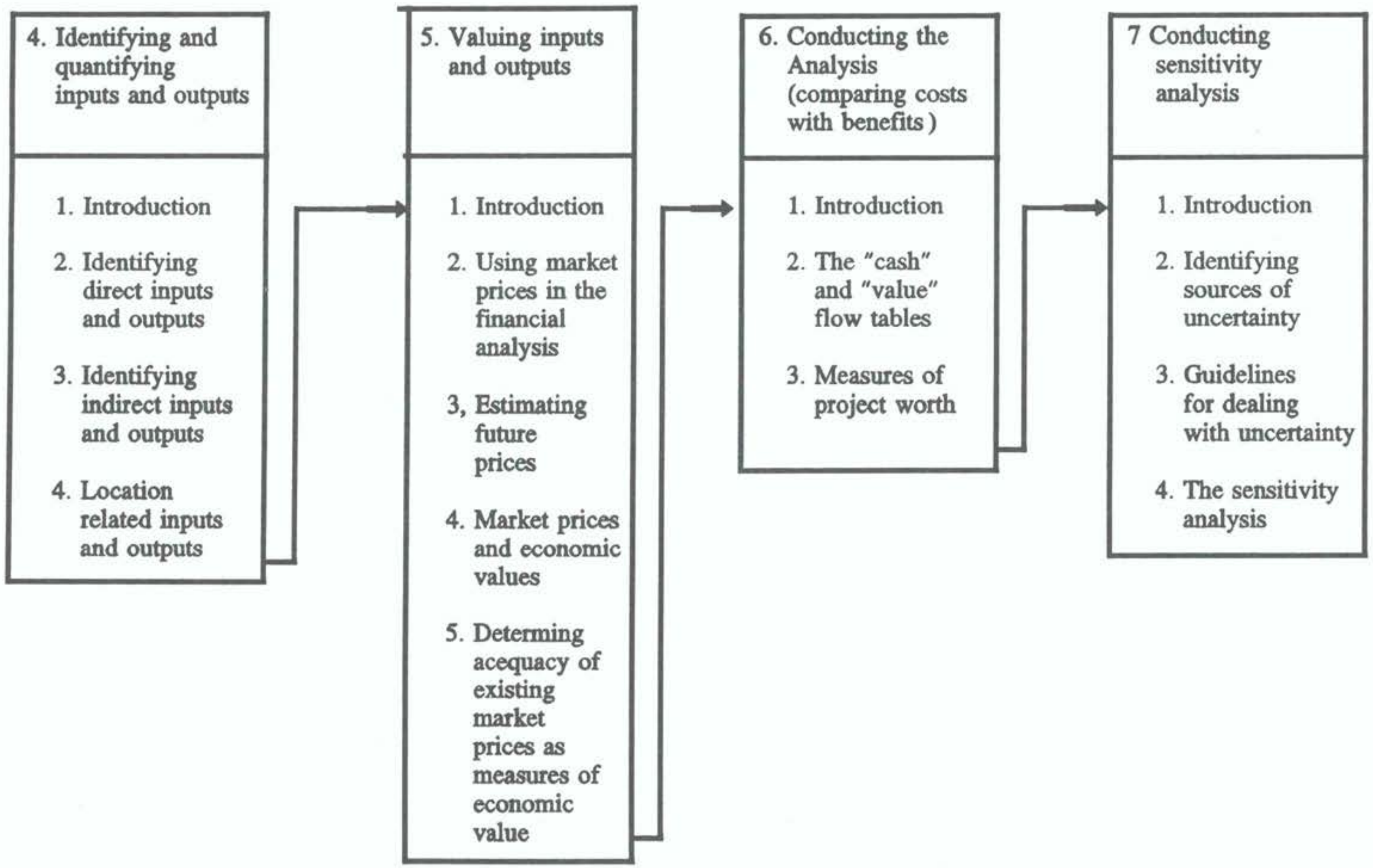

Figure II.1. Part II. Principles and techniques for conducting economic assessments.

4
Identifying and Quantifying Inputs and Outputs

4.1 Introduction

One of the most critical and often most difficult steps in an economic analysis of a forestry project is the proper identification of project inputs and outputs. Estimates of direct inputs are generally the easiest to make. They include such items as labor, land, capital equipment, and miscellaneous supplies.

Estimates of the goods produced, such as fuelwood, timber, fodder, and so forth, generally also can be dealt with in a straightforward fashion. However, the environmental services side of forestry is more of a problem in terms of quantifying outputs. Often, these outputs have to be dealt with in a qualitative sense, e.g., in relation to watershed protection, preservation of biodiversity, aesthetic benefits, contribution to nature tourism, and so forth. Much of environmental forestry deals with avoiding losses; and such benefits can be difficult to estimate.

The present chapter lays out a general framework for identifying and quantifying the inputs and outputs associated with different kinds of forestry projects.

In all cases, the same general sequence of steps can be followed:

First, the analyst *identifies project components that can be analyzed separately*, i.e., those for which inputs and outputs reasonably can be separated and analyzed as separate entities in terms of cost and benefit relationships. Separating components is important for two reasons. First, it makes the analysis process more manageable; and second, as indicated in chapters 2 and 3, the conditions for financial and economic efficiency include the requirement that all separable components of a project need to have benefits at least equal to costs. (Financial and/or economic efficiency for the overall project could be increased by dropping those components where costs exceed benefits.) This step is discussed in section 4.2.

Second, the analyst *identifies and quantifies the direct inputs and outputs* that will enter into the financial analyses carried out to answer the relevant financial questions discussed in chapters 2 and 3. These are the inputs and outputs which will be bought or sold by project entities. In most cases, these inputs and outputs will be identified by major classes of project interested parties and, possibly, by other groupings of separable components identified in the previous step. This step is covered in sections 4.3 and 4.4.

Third, the analyst *identifies and, to the extent possible, quantifies the nonmarket inputs and outputs* which will be incorporated into the analyses needed to answer the economic efficiency questions.[7] These include environmental services, protection functions, nontraded outputs for home consumption, etc. (see figure 4.1). This step is covered in sections 4.5 and 4.6.

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[7] The analyst should also include the inputs or outputs that are marketed but not considered in the financial analysis since they are externalities (e.g., loss of wheat production because of downstream pollution caused by the project).

4.2. Project Components: Separability and Interdependence

As mentioned above, the first step in identifying and quantifying inputs and outputs is to decide, on a preliminary basis at least, which project components can be treated as separable ones to be analyzed separately. Project components generally link together in one of three ways. First, there are horizontal linkages among components, i.e., components that are parallel to each other. For example, one could think of the activities of a thousand farm families participating in a tree planting project as one thousand components horizontally linked through the project. The question is whether they should be analyzed separately.

Second, there are vertically linked project components, where one activity or component depends directly on the other being there, e.g., tree planting component and an associated fertilizer component. Vertical components generally involve one-way dependence, e.g., fertilization only makes sense if the trees are there to fertilize; the logic of considering a fertilizer component depends on the trees being planted. The reverse is not the case. One should logically analyze the economics of tree growing without fertilizer and the economics of the tree growing with fertilizer, i.e., for the separable component of fertilization. The question is whether the additional cost for fertilizer is justified by the expected additional benefits (e.g., additional growth per unit time). If not, then that separable component should be eliminated.

Third, there are interdependencies with other projects that need to be considered. In most cases, this boils down to the question of whether or not the appropriate project boundaries have been identified and defined. For example, one needs to address the question of whether a tree plantation for an eventual industrial operation should be treated as a separate project or as a component of a larger integrated industrial/forestry project.[8] Other specific issues relate to the treatment of *time-slice* projects, i.e., projects that include only a part of an ongoing program, where final outputs will occur after termination of the project being analyzed. Concern needs to focus on carryover values and the question of definition of an appropriate project time-frame.

4.2.1 Horizontal project components

Forestry projects may involve two types of horizontal project components. One type is found in projects that are designed to produce multiple outputs, for example, sawnwood and plywood, or joint products such as timber, watershed or soil protection, and wildlife habitat. The second is related to project scale, i.e., where multiple, relatively independent, units producing the same output(s) are combined for administrative or other reasons into one project. Examples would be a community fuelwood plantation project that includes subunits or components in a number of independent communities, or a smallholder farm forestry project that involves support for establishment of numerous small independent plantations on private farms in a given region.[9]

[8] There are some examples of situations where major mistakes were made when tree growing was analyzed separately from the eventual industrial project for which the trees were intended.

[9] For examples, see the case studies outlined in Part III.

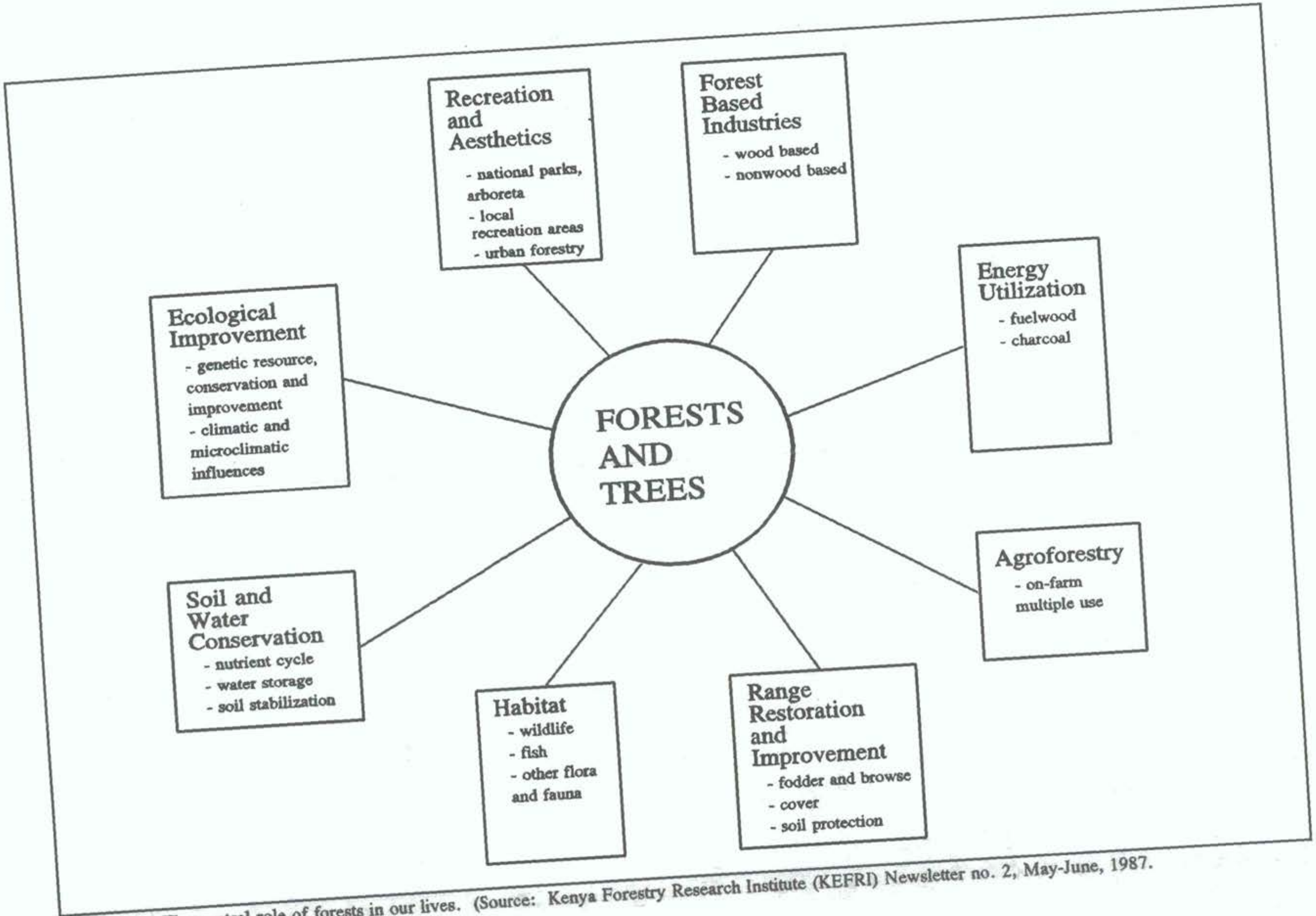

Figure 4.1. The central role of forests in our lives. (Source: Kenya Forestry Research Institute (KEFRI) Newsletter no. 2, May-June, 1987.

For both types—multiple outputs or multiple producers of the same output(s)—there will always be some inputs which are jointly required by all components. If nothing else, since they are encompassed in one project, they will have project administration inputs in common. But quite often they also will have other inputs in common, e.g., infrastructure, marketing services.

In some cases it is possible to undertake separate analyses of each component. A typical situation is where several parallel processing activities are included within the scope of the same project. For example, in a project designed to produce both plywood and sawnwood, the major input items can generally be assigned separately to the two activities (although they also will likely have some inputs in common, e.g., administration, some infrastructure).

In many other types of forestry projects with joint outputs, there is little scope for separate analyses of components, since most of the inputs required to produce the outputs are common to all of them. For example, an agroforestry project may produce wood, livestock fodder, and increased agricultural yields through soil protection. All three outputs (*multiple uses* of the trees planted) result from the same production system and inputs and are thus difficult, if not impossible, to separate from each other in terms of inputs.

In this latter case, the cost of adding on one purpose or output could be analyzed. For example, the extra cost of management and harvesting associated with improvement in the soil protection function of a plantation on a hillside aimed primarily at producing wood and wildlife habitat could be analyzed. But this would not be the same as analyzing the soil protection output as a separate horizontal component, since the additional costs required to obtain the soil protection would not be the same as the total costs for it if taken in isolation.

For a type of project that involves a number of relatively independent units producing the same outputs (such as the fuelwood plantation or smallholder agroforestry examples cited above), there is a different set of questions which is relevant in determining the value of looking at separable units. First, and foremost, is the question of data and information on which to base such separation. If, as is often the case, estimates of *average* or *typical* conditions are used for all the components because of lack of more detailed information, then separate analyses make little sense, since all components will have the same assumed conditions and thus the analysis of each will produce the same results (see box 4.1).

Whether or not separation of components makes sense, even if the information on which to base separation is available, depends on the nature of the particular project situation, the time and funds available for analysis, and the objectives and constraints faced by the relevant institutions involved in the project. It is seldom worthwhile to separate out all components. But it generally is worthwhile to look at some major classes of components in most types of forestry projects. Once the relevant separation has been determined (agreed upon) then the analyst can proceed to identify inputs and outputs by components, developing separate physical flow and unit value tables for each.

Some argue that as long as all inputs cannot be separately assigned to specific components there is little justification for separate analyses of components. The argument is that arbitrary assignment of joint costs is artificial and may lead to wrong decisions. The question is really one of extent. In cases where joint costs are significant in relation to separable costs (say around 25 percent or more of the total costs) separate analyses of components might lead to problems.

Box 4.1. Separability of components when averages are used.

For example, for an agroforestry project in the Philippines involving subsidization of several hundreds of smallholder farmers, the data base was such that the best the analyst could do, given limitations on time and funds, was to use estimates of typical input requirements and typical yields for the area in which the farmers were located. Information was not available on which to base a disaggregated analysis of the relative profitability of different types of farms or different sites. Thus, components were not separated out for separate analyses. Instead, an average farm was analyzed and the results extrapolated to take into account all the expected participants in the project.

Even if more detailed data had been available, it would not have been worth the analyst's time and effort to analyze each potential participant separately. However, separate analyses might have been made for several broad productivity and/or location classes to provide some indication of the relative profitability of different groups within the total project scope. Such information would be useful for establishing priorities in cases where there were more potential participants than funds to support them.

To summarize, for horizontally related project components, the analyst should explore the extent to which inputs and outputs (costs and benefits) can be separated in a meaningful way. If three-quarters or more of the costs required for a given component can be separated out, then it is probably worthwhile to analyze the component separately, using whatever information and judgements are available to allocate joint costs. If none of the project components appear to be reasonably separable in terms of their inputs, then inputs should merely be identified for the project as a whole.

The above relates to analysis of a given project which is already defined in scope. If the economic analysis is being used to help determine an appropriate project scope and content (i.e., in the project identification stage), then horizontal components and alternative combinations of components can be looked at in more detail.

4.2.2 Vertical project components and one-way dependence

Most forestry and forest industry projects also involve distinguishable vertical components or activities, where the output or result from one component is an input into another component in the project. For example, wood produced in plantations is an input into a processing activity, with both being part of a defined integrated forestry and forest industry project. The wood production and the processing are quite well-defined separate activities, if the wood has alternative uses or value other than in the project processing activities. (If it does not have other uses, then it should not be analyzed separately.) The main point to keep in mind when dealing with vertically related components is the concept of one-way dependence. This concept is illustrated with an example in box 4.2.

To summarize, inputs and outputs should be listed by separable vertical components so an analysis can be made of whether or not it makes economic sense to add successive components to the overall project (such as in the example of adding fertilizer to a plantation project).
From these comments on horizontal and vertical components, it can be seen that for most projects there will be a number of intermediate physical flow tables needed for seperable components for

Box 4.2. Vertical project components and one-way dependence.

For example, assume a plantation project for which fertilization is being considered. Applying the with and without concept, the one-way dependence involved between the plantation and the fertilization can be seen. Without the plantation project, the fertilizer obviously would not be applied. Therefore, if it is applied with the project, the *total* costs and benefits involved are properly of concern in the analysis. The plantation project can be undertaken without the fertilization (it is independent of the fertilization), while the fertilization cannot be undertaken without the plantation (it is dependent on the plantation). Thus, the two can be logically separated in terms of analyzing the profitability of the plantation with and without the fertilization, but it would be meaningless to analyze fertilization without also considering the plantation in this particular case.

At the same time, it should be emphasized that it makes sense to analyze the incremental costs and benefits associated with adding on a component. Thus, for vertical components, the analyst should attempt to separate out inputs and outputs, so an analysis can be made of whether or not adding the next higher vertical component involves an addition to the present value of *total* net benefits of the project. To take again the example of a project that envisages possible application of fertilizer to a plantation, assume that the overall return of the project, including the fertilization component, is $1,500 and the total cost is $1,200, both adjusted to take timing into account. If the project is looked at as a whole, the net benefits would be $300 and the project would be considered economically profitable. However, looking at the fertilizer component in terms of additional costs and benefits, the added value yield (benefit) due to the fertilizer is $100, while the cost of fertilizer and its application is $150. Therefore, the fertilizer component involves a net cost of $50 (i.e., $150 minus $100). Total net benefits would be $50 higher, or $350, if the fertilizer component were excluded. According to the second condition for economic efficiency, the project would not be considered economically efficient unless the fertilizer component was eliminated. Only by analyzing the incremental costs and benefits involved can it be seen whether or not a dependent component should be included in the project.

Two points should be emphasized.

1. In this example it was assumed that both establishment of the plantation and fertilization were being considered as components of a project proposal. If the plantation were already established, then the fertilization component would be considered as a separate project and only the incremental costs and benefits involved in fertilization would be analyzed (i.e., the with and without principle would be applied). The same conclusion as above would be reached, namely that the fertilization costs would exceed the benefits.
2. It is also assumed that the wood produced in the plantation without fertilization would have an economic use. The assumption would likely be true in this case. However, in some cases this assumption might not hold; then nonseparable components would have to be dealt with. For example, if the wood to be produced as part of an integrated project has no value other than in the particular processing activity being considered as a project component, then the wood growing separately from the processing activity cannot be meaningfully evaluated. (The two components are not separable.)

the entire project and not just one. Thus, if a project has two horizontally separable components and three vertically separable components for each of the two, it could have six separate flow tables, or one for each of the two horizontal components with three vertical components separated within each horizontal component. A total flow table would also be prepared, once the separable components have been analyzed.

4.2.3 Interdependencies with other projects

The above two types of relationships refer to interdependencies and separability of components within a given, defined project. Two additional types of relationships also have to be analyzed in order to properly identify inputs and outputs. The first relates to interdependencies between the project and other projects over time, i.e., in the case where the project merely represents a part of an ongoing activity or program. This type of project is called a *time-slice* project. The second is the type of interdependency which exists when the output of a given defined project only has one use and there is no practical way of estimating the value of the benefits of the project other than as an input into that use. These two types of interdependencies and their implications for input and output identification are discussed below, together with a special case of interdependency found in forestry, namely, the case of the *allowable cut effect.*

Time-slice projects and interdependencies over time. It is quite common in forestry to find projects that include only a given part of an ongoing program. These are called time-slice projects. Identification of costs and benefits in this type of project can be tricky, since care is needed to identify carryover values from previous activities (projects) which could be entered as costs in the new project and residual values associated with the new project which should be entered as benefits at the end of the new project. This task involves, among other things, distinguishing between sunk and nonsunk or recoverable costs. A sunk cost is an expenditure that already has been made and which cannot be recovered and thus should not enter into consideration in an analysis of appraisal of a project involving decisions about future expenditure or use of resources. With or without the project, the resources are used in the same way in the case of sunk costs. Thus, they involve no change in the project. These types of values are treated as follows:

INITIAL CARRY-OVER OR INHERITED COSTS AND TREATMENT OF SUNK COSTS. In a time-slice project, i.e., an investment in continuation or expansion of an ongoing operation, resources used in the present operation which also will be used in the continuation or time-slice project should be treated as follows according to the important general rule that analysis should be based on the difference with and without the project:

- if the resource would actually have been used in some other productive use in the absence of the proposed continuation project, then it must be included as an input in the economic appraisal of the continuation project and given some positive value;

- if the resource that will be used in the continuation project has no use other than for the proposed continuation project, then it should be included as an input but valued at zero in the economic analysis.

RESIDUAL VALUE AT THE END OF A PROJECT.[10] Most projects have capital assets (land, buildings, equipment, etc.) which have differing lives. If some capital asset has a life that is longer than the project period chosen, i.e., the asset has some other use at the end of the project, then the value in that other use should be entered as a *residual value* or benefit at the end of the project. The argument is exactly the same as in the case of carry-over or inherited costs, except residual values are entered as benefits instead of costs, since when the project is terminated, it releases resources (or goods and services) which can be used in producing other consumption goods and services.

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[10]Residual value is often referred to as *salvage* value. However, in the case of land, it seems awkward to refer to value of land at the end of a project as salvage value. Thus, the more general term, *residual* value, is used.

Residual values are common in financial analyses, since most often a purchase cost of an asset is entered into the accounts at the time it is paid for, and this purchase cost takes into account the expected stream of benefits foregone during the entire life of the asset, not merely for the time during which the asset will be used in the project. Thus, when a land purchase cost is entered in the financial analysis, it theoretically takes into account the value of the alternative benefits which the land could produce forever, not merely during the project time span. Thus, if the land has a use beyond the time span of the project (as it normally does) then a residual value should be entered at the end of the project to take into account the fact that the land will be sold or put into some other use when it is released from the project.

In an economic analysis, the theoretically correct way to enter the opportunity cost of land is to enter each year an annual value foregone by using it in the project in that year. In this case, since only the opportunity cost of the land during the time in which it is used in the project is entered into the accounts, there is no residual value to account for in the economic analysis. The same goes for other capital assets, again, however, only in a theoretical sense. In reality it is difficult to allow for annual values foregone or opportunity costs for most capital assets. Thus, commonly they are entered at full value at the time they are first committed to the project and, thus, a residual value is relevant. In terms of input identification, this means that an asset is entered once in the analysis as a cost in the year in which it is first committed to the project and then it is entered at the end of the project as a benefit and assigned a residual value which reflects the initial real cost for it plus the value of any improvements resulting from the project which have raised its real opportunity cost.

Residual value should not reflect any real value increase that would have taken place without the project. At the same time, if the real opportunity cost of an asset is increasing over the life of the project, then this should be reflected as a cost to the project in the unit value tables. This could happen, for example, when a new road increases the use value of surrounding land.

Time-slice projects can involve some serious problems in terms of identification and valuation of inputs and outputs. Such complications can be avoided by combining all directly interdependent activities (time-slices) and appraising them as one project. (The time-slice component of relevance can at the same time be analyzed separately in terms of its incremental costs and benefits, such as discussed earlier.)

Oftentimes, time-slice projects involve expenditure of funds for a few years of an ongoing program, with benefits occurring many years after the project is finished, in an administrative sense. The question arises as to how to handle these projects. The answer is clear. All costs required to obtain the output up to the point at which the output from the project occurs must be included in the economic analysis and the outputs must also be included, even if they occur a number of years after the *administrative* life of the project has terminated. In other words, the economic analysis deals with a project as including all the interrelated costs and benefits associated with achieving a given purpose or output. For example, if after official termination of an extension project, new farmers adopt the practices promoted by the project, then the net benefits can be attributed to the project.

Vertical interdependencies between separate projects or activities. In some cases, meaningful decisions about one project cannot be made separately from decisions regarding other projects. Thus, they need to be combined as components of one project. Specifically, the output of one project cannot be valued properly if it only has one use and that is an input into one other specific project or activity. This case relates closely to that discussed in section 4.2.2, except here a project has been proposed which is, in fact, not separable from certain other activities. In other words, in defining a project all major components or activities needed to make the project feasible have to be included (see box 4.3).

Box 4.3. Interdependencies among projects.

A country is contemplating establishment of a pulp and paper mill to produce for the local market. There is no current pulp and paper production in the country. All consumption is based on imported paper. As a start, the country planners propose establishment of a pulpwood plantation project. The pulp and paper mill will come *later*. This plantation project has to be analyzed. A problem then arises since decisions on the plantation project can be made only in terms of decisions concerning the size and type of pulp and paper mill that will be constructed (and when it will be constructed and come on-stream to consume the pulpwood output). Further, since there is no market for pulpwood in the country, there is no practical way to value the pulpwood output from the project.

The best way to get around this problem would be to take one step back and redefine the project to include both the plantation activities and the pulp and paper processing activities. If this were done, then the dimensions of the plantation component could be better defined in the context of the intended use for the wood output, and the wood could be treated as an input into the processing activities rather than as a project output that is difficult to value as such. The output of the project in this case would be paper.

If the analyst runs up against this type of situation, the best s/he can do is to suggest that the separate projects be combined into one, or if that is impossible, then merely look at the cost side of the wood production. Of course, if there is an alternative use for the wood from the plantation, then a measure of value could be derived on the basis of the willingness to pay for the wood in that other use. However, in many cases, particularly in developing countries where totally new activities are being introduced, such alternative uses do not exist.

Since this problem really relates centrally to the problem of output valuation, it is discussed further in chapter 5. Here the subject is raised as a point to watch in defining the scope of a project.

Other interrelationships between various activities are relevant in defining the best project scope to meet a given objective or purpose. For example, several activities which have initially been defined as independent projects may be complementary in one of several ways. It may be that to take full advantage of such complementarities these activities should be combined into one project. For example, if the residues from a sawmilling project could be used in particleboard production, then consideration should be given to designing a project that includes both.

The special case of the "allowable cut effect" (ACE). Increasingly, foresters are being introduced to the concept of the ACE and its potential for raising rates of return from plantation projects. The basic concept is that if a country has an even flow sustained yield policy and has a lot of old growth or mature forest that is not adding any appreciable net increment, then by establishing a plantation and considering it as part of the old growth forest unit, the allowable cut of the old growth can immediately be increased, under the assumption that the plantation volume will become available to meet the even flow constraint in the future. The value of the increased volume of old growth harvested immediately is then attributed to the plantation project as a benefit. Since this benefit occurs immediately, rather than in the future when the plantation wood is merchantable, it tends to increase the present value of the net benefits of the project.

Whether or not this is an appropriate approach to attributing benefits depends directly on the assumptions made with regard to policies. If it is assumed that the even flow sustained yield policy will remain in effect, then the allowable cut effect would appear to be appropriate. This follows from application of the with and without concept. Without the plantation project, the additional wood would not be harvested now due to the even flow sustained yield policy constraint. If the allowable cut is an actual constraint (i.e., if there is demand at prevailing prices for more wood than is allowed each year), then with the project the additional old growth will be harvested. Thus, due to the project (and how it relates to policy) the additional wood is made available to society now and this is identified as the benefit due to the project (see box 4.4).

Box 4.4. The allowable cut effect (ACE).

There is much controversy about the legitimacy of invoking the ACE in economic analysis. It may be an effective policy tool, but to use it as a means to justify investments in forestry is another matter. The problem is simple—is it legitimate to label as benefits the old growth volumes harvested as a result of having invested in new and fast growing plantations? Is there a cause and effect relationship between investing in new growth and harvesting old growth elsewhere in the forest?

Consider two owners of forest land, A and B. Individual A owns one hectare and B 100 hectares. A's land is bare and only one hectare of B's land, identical in productivity to A's land is also bare. The rest of B's land is stocked including 10 hectares of old growth. Both A and B decide at the same time to plant their bare land (one hectare in each case) with the same tree species and manage their new stands with exactly the same management intensity. Given these assumptions A's rate of return on investment should not be any different from B's. However, under a policy of nondeclining even flow, sustained yield, B can, on the strength of the new and fast growth, begin to harvest the old growth and thus generate immediate revenues. B's return on investment is therefore much higher than A's.

From the economics perspective, the first scenario is correct, the second is not. It is not economically legitimate to link the two to demonstrate economic attractiveness because the investment in B's bare land has nothing to do with the fact that B also has a "savings account" of old growth to deplete. The returns on investment should be the same for both A and B. B's high return is attributable to a depletion of the old growth savings account, not to the investments made on the one hectare of bare land.

A commonly heard argument is the following: Since the wood could be obtained by merely changing the policy, how can the benefits be attributed to the project? The answer goes back to the basic assumptions underlying the measures of value used in the type of economic analysis discussed here. Opportunity costs as defined here relate to opportunities that *actually are feasible,* given the expected political and social environment which is expected to exist. Any policy could be changed. But the relevant question is: Will it be changed? If the even flow sustained yield policy is expected to remain in effect, then the ACE is a legitimate approach to benefit valuation, and the appropriate output to identify and enter into the physical flow table is the volume of old growth timber that will be harvested immediately due to the project. In a sense the ACE becomes a way of modifying or circumventing the even flow sustained yield policy impacts.

The even flow sustained yield policy and the associated ACE policy are two classic examples of policies that are not designed with maximum economic efficiency in mind. They are, therefore, prime candidates for a *policy analysis,* i.e., an analysis of the impacts of a given policy.

4.3 Identifying Inputs and Outputs: General Considerations

Once the analyst has determined what project components to separate for the analysis, the next step is to identify the inputs and outputs associated with those components. In the economic analysis, any effect which results in an increase in desired goods and services available for society is a *positive* effect and any effect which results in a reduction in quantity and/or quality of goods and services available for other uses (including environmental effects such as reduction in quality of water downstream) is a *negative* effect. Increases or decreases can relate to either or both quantity and quality of goods and services. The theoretical goal at this stage is to identify all the effects of the project on society. In practice, it is only possible to identify some of them due to lack of available information and lack of time and funds to generate additional information.

For the purposes of identification, a distinction is made between direct inputs and outputs and indirect effects. This is done more for convenience than for any conceptual or theoretical reasons. The terms are defined in relation to the financial analysis and the physical flow tables derived for use in estimating commercial profitability. In this context, direct inputs and outputs are those which enter into the financial analysis (i.e., are directly traded for money in a market) and indirect effects are all those other [often nonmarket] effects which are not considered in the financial analysis).

A point to note is that a given effect is defined here as being direct or indirect, depending on whether or not it is traded directly in the market in a particular project situation and environment. For example, in one case fuelwood may be traded in the market, while in another case it is produced and distributed *free* using some quota or other allocation mechanism. In the latter case, it would not have entered into financial accounts as a revenue (receipt). In the former it would have been considered in a financial analysis (see box 4.5).

Similarly on the input side, a given input can be direct or indirect in the context of the definitions, depending on whether or not it is paid for by the entity for which the financial analysis is carried out. For example, if the government provides and pays for certain roads required for a private plantation project, then the cost of such would not enter the financial analysis for the private entity for which the analysis is being done. It would still be an input into the project from the economic point of view and should be identified as such. If the private project built the road, even though it was fully paid for (subsidized) by the government, then it would have appeared in the financial analysis. (See chapter 6 where treatment of subsidies in the economic analysis is discussed.)

It does not matter whether an effect is labelled as direct or indirect. The distinction is made for convenience and to remind the analyst to look beyond the financial analysis for effects associated with a project.

With this in mind, the identification procedure suggested here, and discussed in the remainder of the chapter, is as follows:

Box 4.5. Classification as direct or indirect output depends on the situation

Natural forests and their outputs/uses provide an example of how site and situation specific one has to get in defining direct and indirect outputs (i.e., those that enter the financial analysis and those additional ones that enter the economic efficiency analysis). As can be seen in the following listing, most of the outputs might or might not be traded in markets in any given situation.

<u>Outputs that may or may not be traded in markets in a given project situation</u>

Outputs that are consumed:
- timber products (commercial/noncommercial)
- fuelwood and other biomass fuels
- fruits, nuts, leaves, etc.
- lab animals, genetic materials, skins, etc.

Outputs that are not consumed, but often are paid for in financial terms:
- scenery/recreation use (jungle cruises, trekking, wildlife photography, etc.)
- soil protection/watershed protection (downstream land/water users paying upstream populations for services to protect soil)
- existence values (people valuing a forest just because it is there)

<u>Outputs which so far are not paid for through market transactions</u>

- sociocultural services, i.e., living environment, for indigenous peoples.
- protection of biodiversity (which may eventually lead to marketed outputs)
- gas exchange and carbon storage

1. Using the various technical studies available for the project, identify direct inputs and outputs. To the extent that separable project components have been identified, divide up the direct inputs and outputs by components. These can be listed in separate physical flow tables for components and added together at a later, summary stage in the analysis (see section 4.4).

2. Identify the indirect effects due to the project. List these by separable components, if possible, as indirect positive effects if they add to the aggregate quantity/quality of goods and services available for consumption, or as indirect negative effects if they involve reductions in the quantity/quality of goods and services available (see section 4.5).

In identifying both direct and indirect effects, it is important to distinguish them on the basis of what the resulting information will be used for in succeeding stages in the analysis. Thus, they should be divided and distinguished in categories which make sense from the point of view of valuation and in terms of the types of sensitivity tests which will be included in the analysis. Generally, project activities should not be listed as *inputs,* since values will normally be attached to the inputs required to carry out the activities and not the activities themselves.[11] For example, it is not enough to identify *land clearing* as an input in a plantation project analysis.

[11]Summary tables may present costs by activities, but these summaries can only be derived by estimating the inputs actually required to implement them.

Rather, land clearing can be a heading in the physical flow table, but under it should be listed requirements for various types of labor and supervision, machinery, tools, etc. Similarly, if at all possible, structures that will be constructed as part of the project should be broken down by the component inputs required to build them, and roads should be broken down by labor, machinery, and various materials required instead of just listed as *roads*. If this is not done, it becomes difficult at later stages to develop proper values, since it is the inputs which are required to build the roads which are shadow priced or valued.

4.4 Identifying Direct Inputs and Outputs

The direct inputs and outputs are generally the most important in terms of total project costs and benefits and are central to the economic as well as the financial analyses of a project. Commonly, the identification of such effects is done at the same time for both analyses. In most analyses of forestry projects, they are the only effects which have been given explicit consideration in terms of monetary values.

4.4.1 Direct inputs

The main source of information on direct inputs will be the engineering and other technical studies available at the time of the analysis. The various input categories for the project and for its separable components are defined and the relevant quantities are then entered in physical flow tables by each category and for the year(s) in which they are needed. The listing of inputs is done in a form that will facilitate valuation at a later stage. The types of main input categories which are relevant for most projects are shown in table 4.1. The table provides only a convenient checklist which will have to be expanded both in breadth and detail for particular cases.

Input categories shown in table 4.1 can be listed in a number of different ways by subcategories related to (1) phases of the project, (2) activities or components within phases, and (3) by foreign and domestic sources for each phase and activity. There may be three major phases

- project planning (preinvestment phase);
- investment phase (construction, i.e., fixed investment and preproduction capital costs); and
- implementation or production phase.

Activities within each phase will differ with the project being analyzed. Production activities (or components) will often include raw material production, processing activities, storage, sales and distribution. In many types of forestry projects it makes little sense to separate the investment phase from the production phase for the economic analysis. It is often preferable to treat the two together and distinguish activities such as site preparation, planting, crop maintenance and management inputs during the growing period and harvest and transport. The only general rule for establishing appropriate categories is that the analyst classify inputs in a way that makes sense in terms of the objective of the analysis, i.e., the derivation of the total value flow table and the measures of project worth. Some examples for specific projects are given later.

Table 4.1. Categories of direct inputs.[a]

Inputs Category	Comments
1. Manpower	A distinction should be made between male, female or child labor, unskilled and skilled labor, staff, consultants, and the seasonality of availability.
2. Land	Land can be further broken down into categories to reflect different uses and values.
3. Equipment	Working tables will be needed with detailed listings of equipment required and timing of such requirements. In the final tables, some major subcategories can be used as derived from the detailed tables. Replacement requirements have to be included.
4. Raw materials	Such items as utilities (energy, fuels, etc.), wood raw material, if purchased, chemicals and other purchased inputs, and water can be listed separately.[b]
5. Structures and civil works	If structures and civil works (housing, roads, other facilities such as dock and harbor services) are purchased or rented outright, then they would appear as separate inputs. However, if the project itself involves construction of such works, then they should not be listed as inputs as such. Rather, the component labor, land, equipment and raw material requirements for constructing them are listed.
Note: See text for further discussion of how these inputs should be listed by subcategories related to (a) phases of the project, (b) activities or separable components, and (c) foreign and domestic sources.	

[a/]As mentioned in the text, depending on the situation, some of the listed inputs may be indirect instead of direct, e.g., in the case of infrastructure such as roads, community facilities, etc. It all depends on whether or not they are directly paid for by the project entity for which the financial analysis is being done.
[b/]If raw materials, such as wood, are produced as part of the project itself, then the component input requirements are listed rather than the raw materials such as roundwood (see text).

If balance of payments effects are of particular concern to decisionmakers, then all inputs can be listed separately by domestic and foreign sources.

The amount of detail required for the tables depends on the stage in the planning process. During initial phases, when project identification, preparation and design is the main focus, the analyst may start with very general, rough estimates which can be used to make initial comparisons between alternative technologies, scales, locations, etc. As attention focuseson one alternative design, the detail required increases. When the alternative has been designed and prepared, the analyst may wish merely to summarize inputs by categories and activities or components with headings such as shown in table 4.1. The final appraisal document should not contain excessive details. Rather, reference can be made to the supporting studies, so the decisionmaker can find details, if so desired. The analyst should not be forced to wade through them to put the logic of the project and its appraisal clearly in perspective.

4.4.2 Direct outputs

Direct outputs can also be derived from the basic technical studies and from market studies which are a basic element for projects involving direct outputs.

There are two types of potentially direct project outputs which sometimes become difficult to identify properly. These can be labelled as *cost savings* and *losses avoided.* Some examples will illustrate them. Assume a project designed to reduce log hauling costs by improving a logging road. This is a cost savings type of project and the benefit from the project is the difference in hauling costs with and without the project, i.e., the cost savings. The *output* can be specified initially in terms of resources saved, i.e., reduced requirements for trucks, maintenance labor and spare parts, etc. These physical measures are then transformed at the valuation stage to monetary measures of costs saved. Similarly, a watershed protection project may be contemplated to reduce the cost of dredging of a reservoir that provides flood protection and regulates water flows for dry season use. The reductions in dredging equipment, labor, etc., required are identified as the physical measures of output or resources saved. (They are then valued in the next stage on the basis of what these released resources can produce elsewhere, i.e., the willingness to pay for the additional goods and services which these released resources can now produce in alternative uses.) In both cases, the relevant final comparison is between costs of alternatives, i.e., *cost savings* projects are considered in terms of the third condition for efficiency or by applying a least cost analysis.

It should be noted that cost savings projects can also be oriented toward preventing future cost increases. For example, the relative price for labor may be increasing and a project could be proposed gradually to reduce the labor input into a particular activity so that total unit costs can be maintained at present levels or at least prevented from increasing at a rate that would occur if the project were not undertaken. This type of project is closely related to projects designed to prevent losses.

In the case of projects that are aimed at preventing losses, the relevant comparison is between the value of the losses avoided and the costs of avoiding the losses through the project measures. Thus, at the identification stage, outputs are identified in terms of physical losses avoided. The approach is illustrated in a FAO document for a watershed protection project which involves land use improvements to reduce siltation in a reservoir.

Reduced siltation results in reducing the loss of storage capacity, which in turn results in reducing the downstream losses which are caused by the decreasing water availability from the reservoir. The losses avoided, or benefits in this case, are identified in terms of such downstream uses (since these are what society values, not the capacity of the reservoir itself).

Similarly, forest protection projects are aimed at reducing the risk of loss due to fire, insects, disease, etc. In these cases the probability of loss without the project and the reduced probability of loss with the project have to be estimated. The difference is the output or benefit due to the project. This task is appropriately done by the technical experts. Once such information is available, the task of the economist is to take the appropriate estimates of physical losses avoided and attempt to value them in a time context. Since the estimates of physical losses avoided will be subject to probabilities, so will be the values of these losses avoided. At the input and output identification stage, there are no particularly unique problems involved, although analyses involving probabilities are always more complicated to carry out (and require more data) than those involving the assumption of certainty.

Finally, there is the situation mentioned earlier where a project involves both losses avoided and production (output) increases over present levels. For example, assume a situation where an area of hill land is deteriorating due to erosion taking away the productive top soil. It has been estimated that the production from the land will decrease over a 20-year period from level A to zero (point B) in figure 4.2. Now a project is proposed to build up production to level C in ten years and then maintain it at that level during the life of the project (year 25). The appropriate measure of output is area ACDE, *plus* the loss avoided, or area AEB. If only the production increase over present level were included, it would understate the output or benefits of the project.

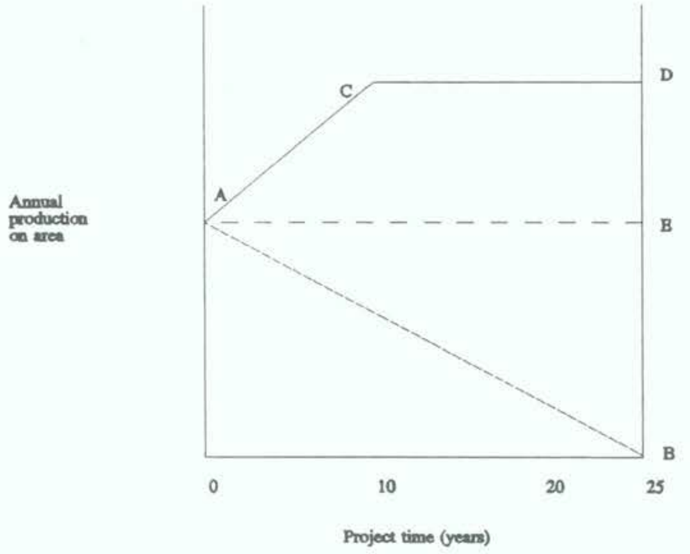


Figure 4.2. Soil protection benefits.

If production is expected to continue at level C beyond the 25 year life of the project, then the benefits or output of the land beyond that period should also be included in the project calculations *net of any additional costs* required to maintain production at that level. In otherwords, at the end of the project period, there is a residual value (such as explained in chapter 3) that can be attributed to the project. It can be seen that application of the with and without concept is critical to proper benefit identification in these cases.

Table 4.2 provides an example of a physical flow table for a forestry project, showing how direct inputs and outputs are organized and how inputs are listed in the year(s) in which they are used and outputs by the year(s) in which they occur.

4.5 Identifying Indirect Effects

An indirect effect was defined earlier as any change in the quantity or quality of goods and services available to society due to the project, but one that does not enter into the accounts for the financial analysis, since it is not directly bought or sold in a market by the financial entity for which the financial analysis was done.

Table 4.2. Timing and magnitudes of physical inputs and outputs for assumed "average" 10 ha farm.[a]

Item	Units	Years															
	(per 10 ha)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inputs Land preparation, lining, digging and planting	m.d.[b]	74	74	74	74												
labor	m.d.	38	38	38	38												
seedlings	no.	1200	1200	1200	1200												
Replanting																	
labor	m.d.	16	16	16	16												
seedlings[c]	no.	300	300	300	300												
Fertilization																	
labor	m.d.	25	25	25	25												
fertilizer	kg.	4	4	4	4												
Weeding	m.d.	68	68	68	68				34	34	34	34	34	34	34	34	34
Singling	m.d.									25	25	25	25	25	25	25	25
Output Pulpwood stumpage $m^3(r)$									184.1	205.8	205.8	227.0	227.0	247.8	247.8	268.2	205.8

[a] From Case Study no. 1. See FAO 1979.

[b] man days

[c] Assumed that 25 percent would have to be replanted on the average.

A first point to note about indirect effects is that many of them cannot be meaningfully valued in monetary terms. However, they should still be identified in quantitative physical terms, if possible, and otherwise at least specified in descriptive terms. Regardless of whether or not they have an identifiable monetary value, they may be important in the broader context of decisionmaking, where many considerations other than monetary values are important.

A second point is that whenever an indirect positive effect is identified, the analyst should be careful to search for any corresponding indirect negative effect (cost) required to bring about the positive one. It is only the *net* indirect effect that can be attributed to the project.

The following discussion will illustrate this point.

4.5.1 Indirect positive effects

The following are the main indirect positive effects of concern in forestry projects:

- soil and watershed protection and wildlife and recreation habitat improvements that are not accounted for in the financial analysis;
- benefits accruing to society due to the fact that the project has trained persons to be more productive or has demonstrated the viability of some activity which is then undertaken by entities outside the project boundaries; and
- cost savings which result in output expansion and increased use of excess capacity outside the project, but due to the project activities.

Descriptions of each type follow.

Soil and watershed protection and natural forest conservation. Many projects involving establishment and/or management of forests also produce certain indirect effects in the form of improvements in soil or watershed protection *services* from the land (forest) and, possibly, improvements in wildlife habitats and recreation opportunities. In rare instances, these services are paid for directly to the project and thus enter the financial analysis as direct outputs. However, in most cases they are not directly priced in a market.

Quantification of such indirect effects depends on the availability of input/output information which describes the changes in output that will take place with a given forestry activity. In the absence of such information, there is little that the economic analyst can do to quantify them.

There are some studies which have been carried out for specific regions which link various forestry activities to watershed protection changes and further link these changes to consumption changes downstream.[12] The transferability of such specific results to a broad range of project situations may be possible. The best that can be done is to rely on the judgments and figures provided by the

[12] See Gregersen et al. (1987) for details related to watershed management inputs and outputs.

technical experts. If such effects have been identified in quantitative terms, they enter the analysis in exactly the same way as any other quantified input or output.

Training and demonstration effects. A project may involve training of labor to increase its productivity. The training expenses are likely to be direct inputs into the project; however, the indirect effects due to the training are not accounted for in the financial analysis, since the project financial entity does not collect the increased revenues made possible by use of this better trained labor in other projects when the project is terminated or the labor leaves the project for other employment. It is very difficult to quantify this benefit and particularly to value it. Thus, it is generally included in the analysis in a descriptive fashion, for example, "100 laborers will be trained to operate power saws and this will increase their productivity in future years." The training expenditure also results in benefits in the form of increased output per unit of input in the project itself. These should be accounted for in the direct output measures for the project.

Similarly, in many forestry project situations, extension efficiency and demonstration effects are important issues (see box 4.6). For example, a public project may involve support for establishing fuelwood plantations in selected communities. Once surrounding communities see the benefits to be derived from such plantations, they may on their own undertake to establish such plantations to meet their increasing requirements for fuel and/or to reduce the increases they are experiencing in fuel costs. The *net* benefits resulting from this type of demonstration effect can appropriately be attributed to the project being analyzed (even though the additional plantations resulting due to the demonstration effect are totally outside the project scope). The with and without concept can be applied to see which net benefits would not have been expected to result without the project. They can legitimately be attributed to the project. It should be emphasized though that it is only the net benefits that can be attributed to the project. If the additional outputs are to be attributed to the project, then care should be taken to attribute as inputs the resources and goods and services needed to bring about the additional output.

Cost savings and increased use of excess capacity in other sectors. If a forestry project results in production of lower cost wood than previously (i.e., more efficient wood production) there may be an increase in the use of wood in existing idle processing capacity outside the project boundaries. (The increases will be due to the fact that the price of the final product can be lowered since costs are lowered; demand for such products will increase because of the lower price, and therefore processing can increase to meet this demand.) The indirect benefits in this case will be the increased output resulting outside the project less the cost (the inputs) required to bring about this new production.

Similarly, a road project designed to reduce the cost of delivered wood (i.e., increase efficiency in wood delivery) may have indirect effects beyond the project. Such improved roads may be used by farmers who can lower their effective costs of delivery, thereby lowering farm product prices, which can result in increased demand and expansion of production (i.e., goods available

Box 4.6. Extension efficiency.

Extension efficiency depends on a) the ability of the extension agents to diffuse the message at the local level and b) the *over-the-fence* demonstration effect. On the first point, agent ability varies with extension context and agent personality. Of the farmers contacted by extension agents in a given year, extension will be effective for only some since rural households are heterogeneous with widely different motivations and means to invest. Less than 100 percent of the target beneficiaries will be receptive. On the second point, local participants successfully trained by the extension agents will diffuse their newly acquired knowledge over-the-fence to other farmers. Analysts should take these considerations into account and build in reasonable expectations about the efficacy of the training and extension to be carried out.

Suppose an agroforestry project is being planned in a region of 60,000 cultivable hectares and 10,000 farm households, that 25 extension agents have been trained, and a project time horizon of 20 years. Suppose further that the nature of the forestry interventions to extend is such that one agent is limited to working with a maximum of 25 households each year, visited three times per year for no more than three days each visit; i.e., each household benefits from nine days of extension training during the year.

Next, the analyst should, if possible, factor in whatever field realities they are able to uncover. Suppose that only 70 percent of the households can be assumed to be *trainable* for a variety of reasons, or a total of 7,000 farm households. The 7,000 should be the target population, not the 10,000. Suppose further there is reason to assume (from other experiences) that training will be effective for only 50 percent of the target population the first time exposed to the extension package. The other 50 percent will need more intensive coaxing over time to ensure their participation. Next, the analyst should factor in the over-the-fence demonstration effect—say 20 percent per year—for whom direct extension agent contact will not be required. This assumption should be substantiated by empirical evidence if available.

The results are presented in the form of three scenarios (below). Scenario 1 reflects what most project planners will assume—that the 25 agents will be able to contact 625 households per year and that all contacts will be successful. This means that the target (successful diffusion of the proposed interventions to 10,000 households) will be reached by year 16 (10,000 HH/625 = 16 years). This is comfortably within the projec time horizon of 20 years. The second scenario takes the two factors of trainability (70 percent of the target participants) and training effectiveness (50 percent) into account. Under this most pessimistic scenario, it will not be possible to cover the entire region with only 25 extension agents. In this case, either additional extension agents or a longer time horizon (22 years) will be needed. If the over-the-fence demonstration effect of 20 percent is factored in, however, the target 7,000 local households will be successfully reached within the 20-year time horizon with 25 extension agents in year 19 as in scenario 3.

Scenario 1 is unrealistic since one cannot assume that all households are equally trainable and that they will accept the proposed interventions with equal enthusiasm instantaneously. Scenario 2 is also unrealistic since the demonstration effect has not been taken into account. Scenario 3 is the most realistic since all the factors have been accounted for.

The above discussion demonstrates the need to calibrate forestry investments where local participation is sought, to local field realities. The heterogeneous target region and population should be described, the trainability of target beneficiaries and effectiveness of the training offered should be assessed. The analysis should reflect these local field realities and the time it will realistically take to reach targets.

Years needed to reach target under different scenarios	
1 No trainiability, effectivenss, demonstration effect	16
2 Trainability and training effectiveness	22
3 Trainability, effectiveness and demonstration effect	19

Source: K. Christophersen.

for society to consume). Such increases can be attributed to the project in question (the road project) net of any increases in costs (use of resources) required to bring about these production increases. The appropriateness of attributing these net benefits can again be ascertained by applying the with and without concept.

This type of indirect positive effect should be distinguished from what is generally called a *multiplier effect,* i.e., a short-run increase in income generated outside the project when surplus capacity in an economy is activated by additional rounds of spending resulting from investment in the project. Forest recreation projects are often justified in terms of the additional expenditures which will occur in the communities adjacent to the recreation project. From a national point of view, such *benefits* need to be questioned. In most cases they are merely transfer payments in the sense that the expenditures would occur elsewhere in the absence of the project. Again, application of the with and without concept is critical in identifying true net indirect positive effects associated with such additional expenditures. They generally can be justified only in cases where the funds available for the project could only be used for the project being analyzed and not for any other project in the economy. This would be the case for tied grants and loans which could not be used for anything other than the project in question. In this case, it still only is the net effect which should be included, i.e., there may be additional nontied expenditures—outside the project boundaries—which are required to achieve the benefits or indirect positive effects in question.

4.5.2 Indirect negative effects

There are also certain indirect negative effects which may be associated with forestry projects. The main categories are

- pollution or negative environmental effects not accounted for by direct costs to the financial entities involved;
- increases in costs outside the project boundaries which influence production (cause decreases) elsewhere in the economy; and
- infrastructure costs not included as direct costs, but required for the project.

Pollution and negative environmental effects. The common example given is a pulp mill that pollutes water that is put back into rivers, thereby reducing the quality of water downstream and consumption benefits of downstream water users. Similarly, such a project may reduce air quality. Often a measure can be derived of the amount of pollutants which the mill discharges into a river or lake. In some instances such increased pollution levels can be associated with losses in consumption benefits (e.g., loss of fish catch, increased health problems, etc.). Quite often, however, this type of indirect negative effect is merely described in the project document without making any attempt to value it since the necessary data on input-output relationships are not available. Increasingly, pollution is being internalized in projects through the use of effluent charges or requirements for pollution control equipment or project water purification expenses. In these cases, such effects enter the project analysis as direct effects or inputs, since they involve financial costs and enter the financial analysis.

A similar situation exists with most other types of indirect negative effects involving deterioration of the environment, for example, soil deterioration and watershed benefits foregone due to a project that involves manipulation of vegetation upstream. Considerable research and study has been devoted to watershed problems and potentials for improving watersheds through forestry activities. There are some estimates of quantitative relationships available which may be usefully transferred from one situation to another. The judgment on transferability should be made by the technical personnel familiar with watershed management and the project.

Cost increases affecting production of nonproject output. In some instances, a forestry project may result in the prices for certain inputs being increased. Such increases will affect other producers who have to curtail production. Reduction of their production releases resources, some of which may not be usable in producing other goods and services. If there is a net loss in the value of goods and services available to society due to such a project effect on prices, then this is legitimately attributed to the project as an indirect negative effect. Such a net loss would result if some of the resources released had no alternative uses and thus remained idle when the project-caused cost increases put them out of work. For example, if the project demand for imported machinery results in the price for such machinery increasing to the point where certain other activities cannot afford it and they have to shut down, then they release labor and other resources that may not be able to find alternative employment. The reduced output value from the activities that shut down, less the new value produced by those released resources which find alternative uses, would be a measure of the indirect cost of the project being analyzed.

Infrastructure costs. As mentioned earlier, it is common that some of the infrastructure—roads, community facilities, power generation and communication facilities—which have to be produced for the project are not paid for directly by the financial entity for which the financial analysis is being undertaken. In such cases, the costs associated with such infrastructure have to be included in the economic analysis as indirect negative effects of the project, to the extent that their provision involves use of resources that could have been used in the absence of the project to produce other goods and services valued by society. Both capital and operating costs associated with such infrastructure have to be considered. At the same time if certain infrastructure items will be used outside the project boundaries, then allowance should be made for such use as an indirect positive effect. Again, the with and without test is applied to infrastructure.

If infrastructure is produced and operated directly by the project entity or entities for which the financial analysis is undertaken, then it should have been included in the financial analysis, even if it is entirely subsidized by the government or some other entity not considered in the financial analysis. The exception is if the financial analysis netted the project expenditure against the subsidy. In this case the cost to the financial project entity would not appear in the financial accounts. In such cases, the cost should still be included in the economic analysis. The cost of the infrastructure is real. It is impossible to generalize on how such subsidies and infrastructure expenditures are handled in the financial analysis. In each case the analyst preparing the economic analysis has to look at the project's financial accounts and make sure that costs to society are included and subsidies are appropriately treated as *transfer payments* as suggested in chapter 6.

Common categories of infrastructure which the analyst should examine critically include those shown in table 4.3.

4.5.3 Additional points: Indirect effects

What is to be done in terms of identification of indirect effects? There is no one best way to proceed, since there are few ready and available sources of information on most of such effects. Success in identifying indirect effects depends a great deal on experience and knowledge of relevant interrelationships based on study of other projects and technical literature. Interaction between various technical experts is essential, since identification of most indirect effects depends on information related to technical relationships.

Table 4.3. Infrastructure categories checklist for economic analysis.

Rail (track and rolling stock)
Road (highways and vehicles)
Port
Shipping
Logging facilities (vehicles, equipment, roads)
Power (generation, distribution)
Telephone
Freshwater supply
Stormwater drainage
Sewerage (drains and treatment)
Housing
Education (schools)
Health (hospitals)
Government Agencies (post office, tax department, justice, etc.)
Churches
Recreation facilities (sporting and cultural)
Commercial facilities (shops, banks, hotels, etc.)

Source: R. G. Steele (1979).

Given some general ideas on potential indirect effects of given types of activities the analyst can proceed to estimate whether any given type will be relevant for the particular project s/he is analyzing. If the analyst decides that it is likely to be relevant, then s/he can discuss with technical experts the likely physical magnitudes of the effects (both positive and negative) and list these in a separate table (or tables). Where it does not appear possible to estimate magnitudes (quantities involved) the analyst should still develop a statement describing the nature of the effect expected in as specific terms as possible.

Some indirect effects will be accounted for in the economic analysis through shadow pricing of direct inputs and outputs and will, therefore, not appear as separate costs or benefit items (see chapter 5). For example, if water used in a pulp mill is shadow priced to reflect its true opportunity cost, then this shadow price (cost) should incorporate the value of opportunities for using clean water downstream that are foregone due to the project polluting downstream water. Since identification and valuation are closely interrelated, in practice the two steps are often carried out simultaneously, i.e., a given effect is identified and then valued at the same time. The distinction between identification and valuation here is made for clarity of exposition and to emphasize the point that even though a given effect cannot be valued in monetary terms, it should still be identified and specified as explicitly as possible.

4.6 Location Related Inputs and Outputs (Effects)

As mentioned earlier, inputs and outputs or effects associated with a project should be identified in such a way that the process of valuation is facilitated. Since many inputs and outputs will be valued directly or indirectly on the basis of (market) prices that are established in locations other than those where projects produce outputs or use inputs, it is important to pay special attention to the handling, marketing and transport functions and to properly identify the inputs used in these functions due to the project or saved by producing an output in the project rather than importing it or producing it somewhere else in the domestic economy. This category of effects relates closely to infrastructure inputs discussed previously.

As in the case of infrastructure (and other inputs and outputs), location related effects can be identified as direct inputs and outputs or as indirect effects depending on the nature of the project and the financial analysis being carried out. The important point is that they be included in the analysis and not that they are classified correctly as direct or indirect.

Location related effects which need to be considered can be divided into general ones, i.e., relevant for all types of projects and specific ones, i.e., specific to certain types of projects which involve substitutions (as explained below). In both cases, they only arise when

- the value measure (price) which is to be used for a direct project input is established in a market, or at a point which is different from the point of use of the input in the project, and

- the value measure (price) to be used in valuing a project output is established in a market or location that is different from the point of use of the output and/or different from the point of production of the output.

Thus, this type of effect is one that can only be identified properly in the context of the valuation system which will be used. This emphasizes the point made earlier that in practice identification and valuation often have to be carried out simultaneously for some types of project effects.

4.6.1 General effects

1. For all direct project outputs the analyst needs to identify inputs required to handle project outputs and move them to their intended point(s) of consumption (or export) at

which their values are determined. For example, in the case of an export output, it will be valued on the basis of its export price, generally determined at the port of export. (This will be discussed in the following chapters.) In this case, the inputs—handling and transport—associated with getting the output from the project point of production to the port in which the export price is determined should be included as inputs in the project accounts (the physical flow table and, later, the value flow table).

2. In the case of all direct inputs used in a project, the additional inputs required to handle and to move such direct project inputs (resources, goods or services) from their point(s) of origin (or the location(s) at which their prices are determined) to the point(s) of use in the project need to be included in the project accounts. For example, in the case of imported inputs, which will be valued on the basis of an import price established at the port of import, the handling and transport inputs from that port to the point(s) of use in the project need to be included.

4.6.2 Specific effects

In addition to these two general considerations (which should be considered for all inputs and outputs) there are two special cases where a project can result in positive effects (cost or resource savings) which must be considered and identified where relevant.

Import substitution

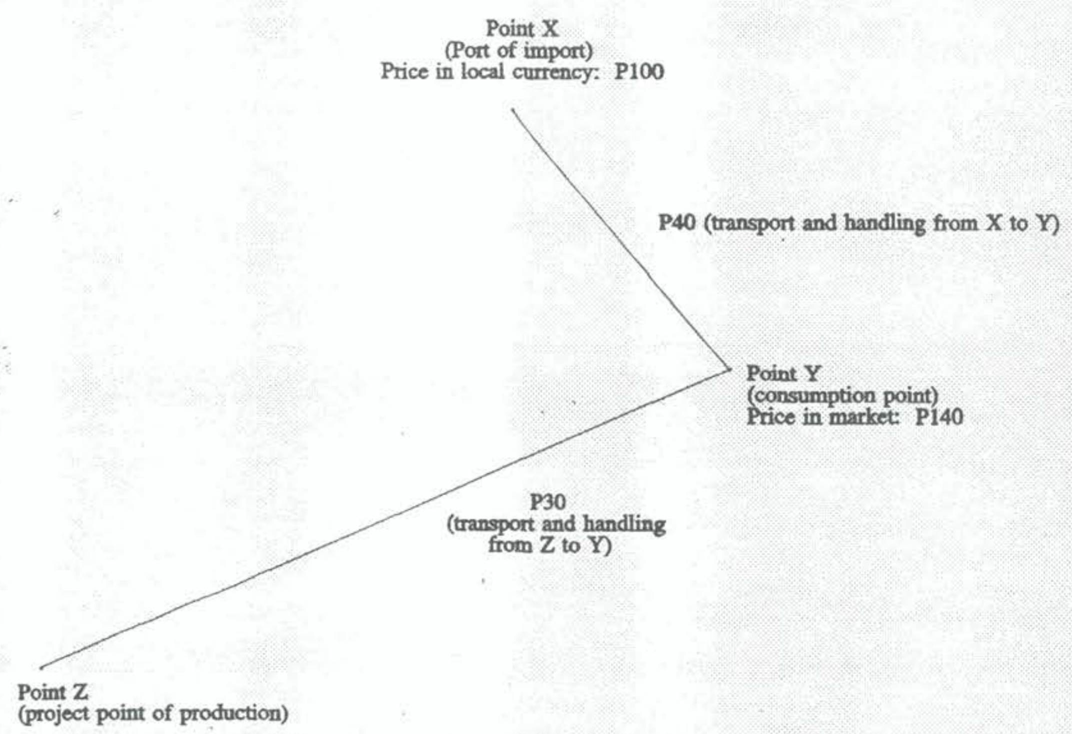
In the case of a project output which substitutes for an import or a domestically produced output, the project will often result in a savings of handling and transport inputs which would have been incurred in the absence of the project. These inputs are saved because the good or service being substituted by the project output will not have to be handled and transported from its point of origin (e.g., port of import) to the market(s) or point(s) of consumption in which its local market price (or w.t.p. for it) is determined. For example, in the case of import substitutes which will be consumed in market A, it will no longer be necessary to handle and transport the import from the port of import to market A. The resources saved due to the substitution are a positive effect of the project, if they have productive uses elsewhere in the economy. This will be determined in the valuation stages. At the identification stage such resources saved due to the project should always be included. (Of course, the effects described under [1] in section 4.6.1 would also be included [see box 4.7 for an example].)

Project inputs which would have been exported

In the case of a project which uses as an input a local resource or locally produced good or service which would have been exported in the absence of the project, use of the input in the project will result in savings in additional resources which would have been required to handle and move the particular project input in question from its point of origin to the port of export to point(s) of use in which its price is determined. These savings of additional inputs are legitimately identified as positive indirect effects due to the project in the stage being discussed here (see box 4.8 for an example).

Box 4.7. Identifying location effects: Import substitutes.

Assume that an import price of a good at the point of import (converted to local currency equivalent) will be used to value the output of a project that will substitute for the import. The local currency equivalent at port of import (point X) is P100. Adding on marketing costs (transport and handling, etc.) to the point of consumption (point Y) a local price of P140 is arrived at (which is here assumed to equal the w.t.p. for the output at the point of consumption). It can be seen that in addition to saving the local currency equivalent of the import price, the additional handling and transport costs of P40 from the port of import (point X) to the market or consumption point (Y) is also saved. This can be legitimately attributed to the project as a separate positive effect (resource savings) in addition to the direct import cost savings which will be used to value the direct project output. Of course, by producing the output at project location X, the transport and handling costs of P30 between point Z and the market (point Y) are also incurred. This additional requirement for transport and handling services is taken care of under (1) in section 5.6.1 as an additional cost (or input requirement) due to the project.

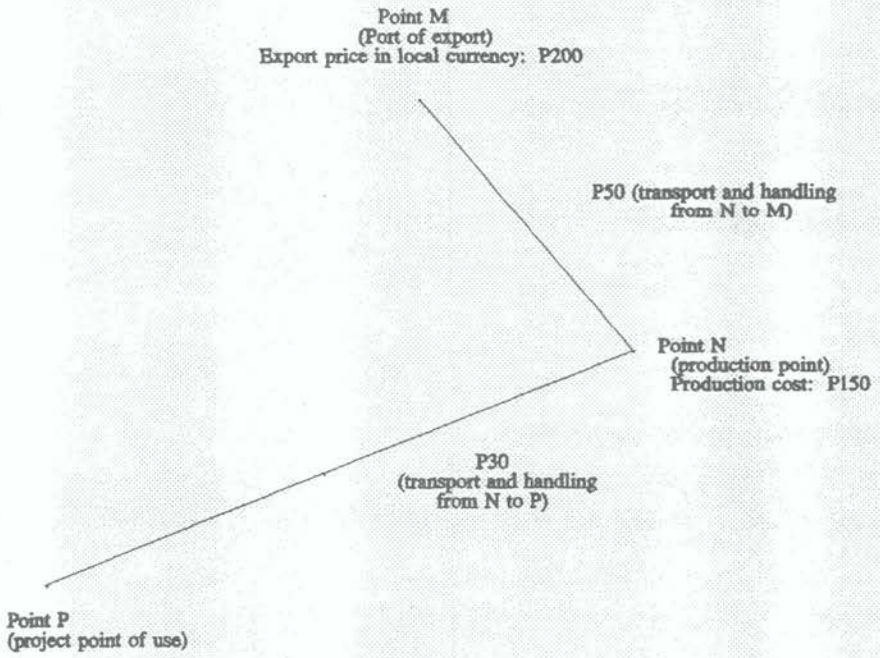


Box 4.8. Identifying location effects: Project inputs which would have been exported.

An example will illustrate this point. Assume conditions as shown below. The local currency equivalent of the export price which would have been received for the input if it were not used in the project is P200 at the port of export (point M).* This value is used as the basis for valuing the opportunity cost of the input being used in the project. However, by using the input in the project rather than exporting it, the P50 worth of transport and handling resources which would have been required to get the resource, good or service in question from its point of origin (point N) to the port of export (the point at which the P200 is determined) is saved. This can legitimately be attributed to the project as an indirect positive effect. Of course, the additional cost of P30 required to get the input from its point of origin (point N) to the project point of use would also be included as additional direct inputs due to the project. (This follows from application of the with and without concept and is taken into account under [2] in section 4.6.1.)

It should be noted that the P50 of resources saved by not having to move the input (resource, good or service) from its point of origin to the port of export from which it would have been exported could also have been netted out of the P200 to arrive at the net opportunity cost associated with using the input in the project rather than exporting it. Both approaches, treating the transport and handling resources (valued at P50) as separate project effects, or netting them out of the P200—would give exactly the same result. Thus, the question is really which of the two approaches provides the best information for decisionmakers or causes the least confusion. It is felt that the former approach causes the least confusion and the least chance for making errors in arriving at the final picture of direct and indirect costs and benefits associated with a project. The recommended approach results in a more systematic process of identification and valuation of all project effects.

* Derivation of the local currency equivalent will be discussed in chapter 5.



In both cases above, the need to include the effects mentioned arises from the nature of the measures of value which are commonly used and the fact that such measures are determined in locations which are different from either the project location or the point(s) of consumption (or export in the case of the second type of effect). In all cases, whether or not the identified additional inputs or indirect positive effects will be assigned a positive or zero value depends on whether or not the additional inputs used or saved have any alternative productive uses (i.e., opportunity costs). This is determined in the valuation stage.

In the following chapter, which deals with valuing inputs and outputs, it will be assumed that location related project effects have been explicitly recognized and identified in this earlier stagein the analysis and thus will be valued independently of values assigned to direct project inputs and outputs. This approach has the advantage of clearly pointing out handling and transport inputs and not confusing decisionmakers by netting out transport and handling costs from established prices used to value direct project outputs or inputs.

5
Valuing Inputs and Outputs

5.1 Introduction—the Approach

Once inputs and outputs have been identified, the next step is to develop appropriate value measures.

In a financial analysis, the valuation process is fairly straightforward and market prices are used for all inputs and outputs. Nonmarket effects (externalities or indirect effects) are not valued in the financial analysis, since they do not enter into the cash flow table of the financial entity.

The valuation process is more complex for an economic efficiency analysis, first, because some market prices for direct inputs and outputs may not be appropriate measures of economic value as defined in chapter 3; and, second, because values for nonmarket impacts are considered to the extent possible.

Box 5.1 illustrates the wide variety of use and nonuse values commonly associated with forest. In most cases we are dealing with a continuum of value conditions, from clearly and easily measured market values (e.g., timber) all the way to existence values and the value of biodiversity that cannot at this time be meaningfully put in a quantitative monetary value framework.

5.2. Using Market Prices in the Financial Analysis

A market price is the amount of money which a buyer (consumer) has to pay at a given time in a given market for a good or service, or the amount of money which the seller of a good or service receives in the market. A market price is determined by the interaction of (1) consumers' willingness to pay for a good or service (demand), (2) suppliers' costs and willingness to sell it (supply), and (3) policies which constrain the free interaction of supply and demand. Regardless of how policies, market conditions, and other considerations affect the final magnitude of the market price, the basic point is that it becomes a fact once a transaction has taken place.

World market prices are particularly useful in an economic analysis as a basis for valuing inputs and outputs that are traded in international markets. There are two main types, namely, export prices (FOB prices) and import prices (CIF prices).

Export or FOB price. The term *FOB* means *free on board* and includes all costs to get goods on board the ship in the harbor (or other means of transport) of the exporting country, such as, project gate prices, local marketing and transport costs, local port charges and export tariffs and subsidies.

Import or CIF price. The term *CIF* means *cost, insurance, and freight* included. It is defined as the price of the good delivered on the importing country's dock or other entry point, and includes the cost of the good at point of export (i.e., FOB price), freight charges to point of import, insurance charges and, in some cases, the cost of unloading from ship to pier at the port

Box 5.1. Use and nonuse values associated with forests.

DIRECT USE VALUES ASSOCIATED WITH

Consumptive Uses

- commercial/industrial market goods (fuel, timber, pulpwood, poles, fruits, animals, fodder, medicines, etc.)
- indigenous nonmarket goods and services (fuel, animals, skins, poles, fruits, nuts, etc.)

Nonconsumptive Uses

- recreation (jungle cruises, wildlife photography, trekking, etc.)
- science/education (forest studies of various kinds)

INDIRECT USE VALUES ASSOCIATED WITH:

- watershed protection (protection of downstream areas)
- soil protection/fertility improvements (maintenance of soil fertility, esp. important in tropical regions)
- gas exchange and carbon storage (improvement of air quality, reduction of greenhouse gasses)
- habitat and protection of biodiversity and species (potential drug sources, source of germplasm for future domesticated plants and animals)
- soil productivity on converted forest land (space and soil productivity for agricultural/horticultural crops and livestock)

NONUSE OR EXISTENCE VALUE

People may value a forest or resource complex purely for its existence and without any intention to use the resource in the future. Simply put, they value their existence, and wish to perpetuate their existence. Many are willing to contribute money, time, or other resources to assist in preserving special endangered species and ecosystems. These economically manifested existence values may be based upon religious, spiritual, cultural, or other values held by individuals or social groups within a society. Although such values are difficult to measure, they should be recognized in valuing the contributions of forests to human welfare.

of the importing country. It excludes import duties and subsidies, port charges at point of entry (e.g., taxes, handling other than unloading, storage and agent fees), and local marketing and transport costs.

Observed market prices for inputs and outputs reflect present and past conditions of supply and demand. Values used in project analyses involve consideration of future supply and demand conditions. Thus, to arrive at future value estimates some adjustments in observed prices and trends in such prices may have to be made. The following adjustments are recommended: (1) adjust future prices to take out the likely effects of inflation; (2) adjust for relative changes in prices of specific inputs and outputs; and (3) adjust for potential impacts of the project itself on future prices. These three considerations are discussed in more detail in the following section.

5.3 Estimating Future Prices

An existing or past market price is a *fact*. It represents what a good or service actually is or was traded for in a given market. Existing market prices can be used directly in valuing inputs and outputs that occur today. When deciding on how to adjust existing prices so they can be used to value inputs and outputs that occur sometime in the future, the analyst has to consider three factors: (1) general price inflation; (2) relative price changes for inputs and outputs; and (3) the *Big Project* effect.

Inflation relates to general price increases which affect all goods and services. Inflation reflects a decline in the real value of money. In addition, there may be relative price changes for some goods or services. Some prices may be expected to change in value more or less than the general level of inflation and, therefore, change relative to other prices. Other prices may be strongly affected by project activities. In developing future value estimates for project appraisal purposes, it is important that the analyst be aware of the distinction between general inflation and relative and other price changes and make appropriate adjustments for them in estimating future values.

5.3.1 Treatment of inflation

The general approach recommended is to work with prices net of inflation, but to include any relative price changes which are expected (see box 5.2). Thus, if prices of all inputs and outputs for the project are expected to increase at the same rate (i.e., at the rate of general inflation), then the analyst can merely use existing prices as a measure of future prices (keeping in mind that actual money prices will increase with general inflation). The advantages of using price estimates net of inflation, i.e., relative prices, are (1) the analyst does not have to try to estimate general price inflation over the life of the project, which is always difficult to ascertain and justify; (2) the results can be understood more easily; and (3) the analyst will be able to show more clearly the assumptions used in the analysis concerning relative price changes.[13]

As an empirical point, it should be stressed that relative price changes tend to be more pronounced in situations of high inflation, as investors search for means to hedge against inflation. For example, high inflation tends to encourage investment in land and other real assets that increase in value at a rate greater than or equal to the rate of general inflation. Bank accounts and certain other fixed return investments, on the other hand, have a tendency not to keep up with inflation because the fixed return becomes less valuable in the future as inflation increases. Thus, relative prices of land and certain other assets may be bid up relative to other prices in periods of inflation as demand for such assets increases.

5.3.2 Estimating relative price changes

It is quite common that some prices are increasing (or decreasing) relative to others. For example, in many countries, the price of stumpage is increasing relative to other prices, i.e., it is increasing at a rate faster than the rate of general price inflation. In cases where relative price changes are expected, the question arises as to how the analyst should attempt to estimate or forecast such changes. Forecasting is an area of specialization in and of itself and can be quite

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[13]For a more detailed discussion on the treatment of inflation and some examples of application in forestry, see Gregersen (1975).

complicated to carry out in practice if it is to be done properly. No attempt is made to cover the techniques and approaches in EAFP.[14]

Box 5.2. Real vs. nominal rates.

The analyst should be conscious of the difference between real and nominal rates. Whenever possible, real rates should be used since they are not disturbed by the influence of inflation. For example, although the price of a good may have increased nominally by 10 percent per year, the real price will actually have declined if the average rate of inflation during the same time period was higher than the average nominal price increase. Real discount and cost and price appreciation (or depreciation) rates can be determined empirically if basic secondary statistical information is available such as consumer and wholesale price indices, interest rates charged by central banks for different kinds of loans, and interest paid for savings, etc. These kinds of statistics are usually quoted in nominal terms including inflation and a risk factor. For example, the table below lays out the "real value" and "current value" approaches. As indicated in the real value approach, by ignoring inflation in the return estimate, we arrive at a rate of return of 5.63 percent. Assuming the best alternative rate of return for the potential investor is 6 percent from a savings account, we might erroneously advise against investment in the forestry practice (say planting, in this case). The error is that we compare a real rate with a current rate.

On the other hand, in the "current value" approach, we inflate our price estimate using an expected long-term inflation rate (estimated here as an average rate of 3 percent per year over the rotation) and arrive at a current-value-based rate of return of 8.8 percent. We compare this to the 6 percent alternative rate (which is also a current value rate) and arrive at the conclusion that the owner should invest in the forestry practice, other things being equal, that is, excluding allowances for risk and uncertainty. (If we had intermediate costs, with this approach, we would also have to consider such costs in current price terms.)

Hypothetical example showing difference between using estimated real and current prices.

Item	Units	(1) "real value"	(2) "current value"
Rotation	years	40	40
Yield at rotation	MBF/acre	20	20
Current price (year zero)	$/MBF	30	30
Real price increase[a]	%/yr	1	1
Average expected inflation	%/yr	(na)	3
Estimated price at rotation	$/MBF	44.57[b]	145.70[c]
Value yield at rotation	$/acre	893	2,914
Cost (year zero)	$/acre	100	100
Internal rate of return(r)	percent	5.63[d]	8.80[e]

[a]Excludes the effects of inflation.

[b]$30\ (1.01)^{40} = 44.67.$

[c]$\{(1.01)\ (1.03)\}^{40} = 145.70.$

[d]Based on "real prices"—$(1+r)^{40} = \frac{\$893}{\$100} = 8.93$

[e]Based on "current prices"—$(1+r)^{40} = \frac{\$2914}{\$\ 100} = 29.14$

[14]The reader can find various techniques discussed in IUFRO (1971) and Chisholm (1971).

In most circumstances the analyst dealing with forestry projects will not be able to use sophisticated forecasting techniques to estimate future prices, and must rely on simple approximation techniques.

If acceptable data on past prices are available and the conditions causing these prices are expected to continue, then the simplest approach is to plot prices over time on a graph. If a trend is evident, then the resulting trend line can be extended into the future. This can be done with regression analysis or simply by extending visually the historical price line on the graph into the future. In working with historical data, there are a number of ways of smoothing out variations that occur from year to year and adjusting for inflation to arrive at a long-term trend estimate which excludes cyclical influences and the effects of inflation.

In this type of trend projection, it is assumed that certain factors (other than the project itself) have affected prices in the past, and are likely to persist into the future over the period of the project. Though this is not always the case, this simple type of projection technique is most often used in practice. For example, in many cases the qualitative features of the product change over the time of the projection. This complicates matters. For example, in the case of a teak forest management project, older stands have been depleted and the new teak of smaller diameter. The price per cubicmeter in these circumstances should be adjusted to reflect these changes in the quality of wood. However, in practice this is very difficult to do in a very convincing manner. Because of this, the analysis of price trends is flawed, but there is very little that can be done about it.

For some forest products, records on domestic prices over time may be limited. In fact, this is the usual situation in countries where the contribution of the forest sector is modest and where statistical services are not well developed. In these cases, the analyst can do little more than try to obtain opinions of knowledgeable people and look at trends in relative prices in other countries and adapt these to the analyst's needs. Alternative price assumptions can be introduced in the sensitivity analysis of project results.

In other cases, accurate records exist covering extended periods, and clear trends are readily perceived. This might be the case, for example, for wages, or for some internationally-traded goods, where records can be obtained from international agencies or from the exporting/importing countries' services.[15]

Some approximations of future price movements are relatively easy to imagine without having much data. For example, if a given region's forests are being rapidly depleted, and population density and the development of general economic activity show a clear increasing trend, the analyst has sufficient reasons to expect a growing scarcity of forest products and rising prices. Thus, the analyst can pick some reasonable rate of increase in prices and test others in the sensitivity analysis.

On the input side, records usually exist on prices of imported goods (in the project country or in neighboring importing country customs files, or in the files of importers). Price trends can be derived from such records and projected into the future.

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[15]cf. United Nations and FAO 1977.

5.3.3 The *Big Project* effect

Naturally, a new project being analyzed has not yet influenced the way in which prices have changed in the past relative to other prices or the rate of general price inflation. However, the proposed project may be large enough in relation to input or output markets to be able to influence prices in the future. Thus, a pulp and paper project's wood purchases may be an entirely new matter or may strongly influence existing wood prices, and its output might add significantly to supply and result in a decrease in future prices for paper. Or the project requirements for given inputs may be large enough to push up the price of these inputs. If information is available on which to base an estimate of how the project is likely to affect future prices, it should be taken into account. It may only be possible to state the direction of the expected influences. Even though the magnitude of the effect often cannot be estimated, the analyst should still include information on the expected direction of change, so various potential prices can be tested quantitatively in the sensitivity analysis.

5.4 Market Prices and Economic Values—Some Definitions

Market prices should be used in the economic analysis to the extent that they reflect economic values. Therefore, the first logical step is to separate out all those inputs and outputs which are associated with market prices.

Before the adequacy of existing market prices as measures of economic value can be usefully discussed, it is necessary to have clearly in mind the meaning of the terms *market prices* and *economic values*. As defined in section 5.2, market prices are the prices that buyers pay and sellers receive for goods and services bought/sold in a given market.

The basic measure of *economic* value is consumers' willingness to pay (w.t.p.) for goods and services, given existing policies which affect w.t.p. In the case of inputs or costs, the term *opportunity cost* (OC) is often used. As discussed in chapter 2, the cost of using an input in the project being analyzed is the value foregone by not being able to use it in its next best alternative use, i.e., its OC. However, the value foregone is measured in terms of consumers w.t.p. for the goods and/or services foregone. Thus, both in the case of benefits (outputs) and in the case of costs (inputs) w.t.p. is used as the basis for valuation in the economic analysis.

While this provides an adequate conceptual definition of economic value, it is necessary to be more specific when it comes to applying the concept in practice and deciding on exactly what measure of economic value is appropriate for valuing different types of outputs and inputs.

Figure 5.1 provides a general overview of valuation approaches to be used in the economic efficiency analysis. The remainder of this chapter and the attached annexes discuss the approaches in more detail for various output and input categories.

5.4.1 Appropriate economic value measures for different types of outputs

For analytical purposes, project outputs can have three types of effects (see figure 5.2). First, a project output can increase the total domestic supply of a good or service available to society. This produces two categories of outputs (see output categories I and II in figure 5.2): (1)

consumer goods or services, and (2) intermediate or producer goods or services (i.e., project outputs which will serve as inputs in other production processes which produce consumer goods). In the former case, the appropriate measure of value is the consumers' w.t.p. for the output of the project itself. In the latter case, the appropriate value measure is producers' w.t.p. for the project output, which in turn is based on consumers' w.t.p. for the other goods and services which will be produced with the output from the project being analyzed.

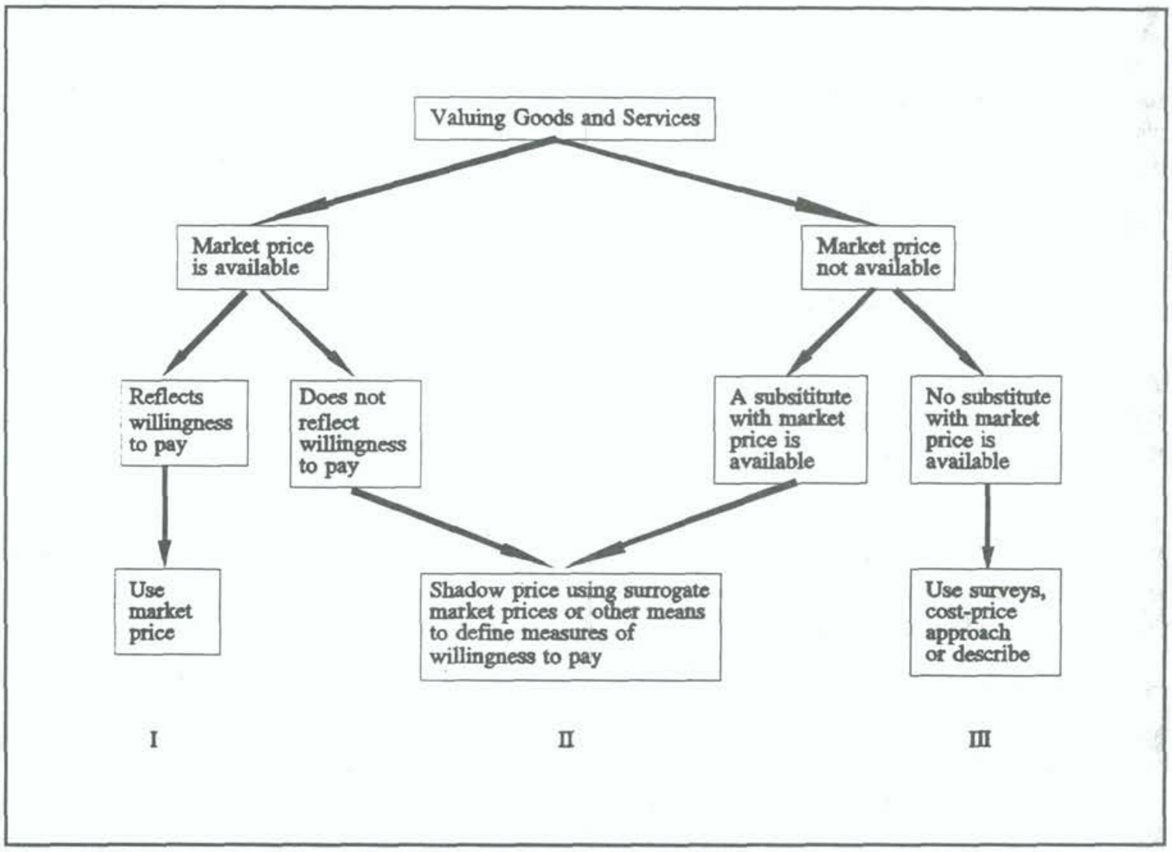

Figure 5.1. Valuation conditions and approaches (Gregersen et al. 1987).

The second effect of project outputs is to increase the availability of foreign exchange to the economy. This also produces two categories of outputs (see categories III and IV in figure 5.2): (1) exports, and (2) import substitutes. The value of these project outputs are measured in terms of the local w.t.p. for the goods and services which can be purchased with the foreign exchange earned (in the case of exports), or the foreign exchange saved (in the case of import substitutes). Since it is necessary to measure economic values in terms of local consumers' w.t.p. for goods and services expressed in local currency, the foreign currency earned or saved has to be converted to local currency, and government policies which make local w.t.p. differ from what the country actually has to pay for imported goods and services in terms of foreign currency have to be taken into account. Unadjusted CIF and FOB values (converted to local currency) may not reflect w.t.p. in cases where a government imposes tariffs or provides subsidies for exports and imports.

The third effect of project outputs is to substitute for other domestic supply, thereby releasing resources for other uses elsewhere in the economy (see category V in figure 5.2). Here the relevant measure of economic value is the opportunity cost of the released resources, which is based on the w.t.p. for the goods and services which will be produced with the released resources.

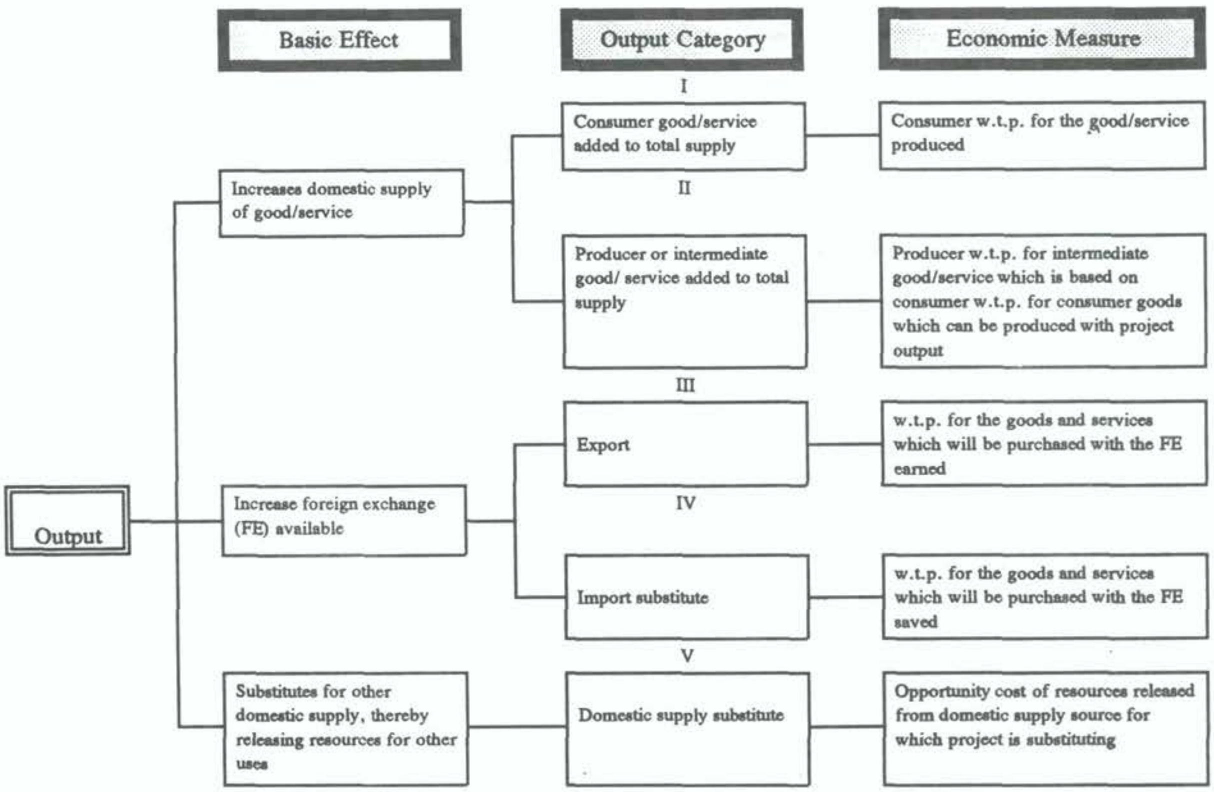

Figure 5.2. Outputs: Measures of economic value.[16]

Section 5.5 discusses how to determine the appropriateness of market prices and the factors which are likely to cause a discrepancy between the local market price and the economic value for these five categories of outputs.

Means for deriving the measures of economic value for outputs are discussed in annex 5.1 for cases where market prices are not considered appropriate.

5.4.2 Appropriate economic value measures for different types of inputs

Inputs used in a project can have two basic economic effects (figure 5.3). They can: (1) reduce the availability of foreign exchange for the rest of the economy, and (2) reduce the availability of real resources or inputs to the rest of the economy. A reduction in the availability of foreign

[16]The decision tree approach to presenting valuation rules was suggested by Ward (1978).

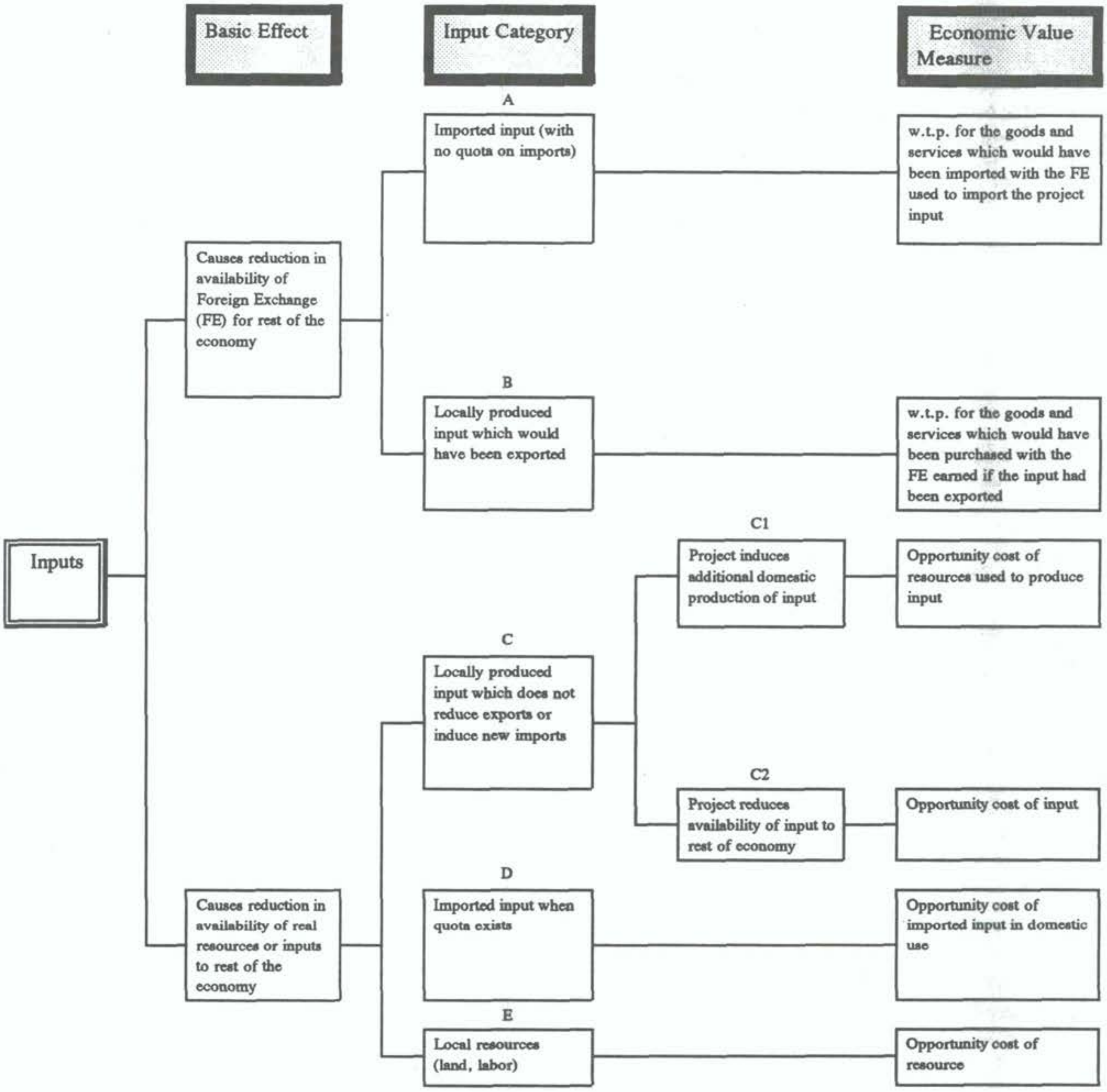

Figure 5.3. Inputs: Measures of economic value.[17]

[17]The decision tree approach to presenting valuation rules was suggested by Ward (1978).

exchange may result from use of imported inputs when no quota exists, or from the use of locally produced input which otherwise would have been exported (input categories A and B in figure 5.3). Where inputs are imported (input category A), the appropriate measure of opportunity cost is based on the w.t.p. for the goods and services which could have been bought with the foreign currency or foreign exchange spent on the imported inputs for the project. This category also includes project use of a locally produced input in short supply that forces a previous user of the input to import the input. In either case—direct use of imported input or forcing someone else to import it—the effect is the same, and so is the value measure that is appropriate.

For locally produced inputs which would have been exported if they were not used in the project (input category B), the appropriate measure of opportunity cost is based on the w.t.p. for the goods and services which would have been purchased with the foreign exchange which would have been earned from exporting the inputs if they were not used in the project.

The second effect of using project inputs is to reduce domestic real resources or inputs available to the rest of the economy when an input is diverted from other domestic use to the project. Here three categories of inputs can be distinguished: (1) locally produced inputs which do not reduce exports or induce new imports (input category C, figure 5.3); (2) imported inputs when a quota exists, i.e., a quantitative restriction exists on imports of the input (input category D); and (3) local resources, primarily land and labor, which are not *produced* as such (input category E).

For category C inputs, a further distinction can be made for valuation purposes. If the project induces additional domestic production of the input, then the appropriate measure of economic value is the opportunity cost of the resources used to produce the input. If the project reduces the availability of the input to the rest of the economy, then the appropriate measure of economic value is the opportunity cost of the input itself in its best alternative use. In the latter case, it is the opportunity cost of the input itself, i.e., the value foregone by using it in the project rather than in its next best alternative use. (Note that if other users now import the input, then it fits into category A.)

When a quota exits for imported inputs, and is filled (input category D), there is no additional outflow of foreign currency, since the total amount of the input imported into the country remains the same (at the level of the quota). Thus, the relevant opportunity cost is the value foregone from shifting the imported input from some other domestic use to the project. Naturally, if the quota is not being met, i.e., imports of the input without the project are below the level of the quota, then the quota is not effective and from an analytical point of view the input is reclassified as an imported input with no quota (see item A in figure 5.3).

When project inputs are local resources, the appropriate measure of value is simply the opportunity cost of the resource or the value foregone by using the resource in the project rather than in its best alternative use.

Means for deriving these measures of economic value for inputs are discussed in annex 5.2 for cases where market prices are not considered as appropriate approximations of economic values. The following section discusses some of the factors to be considered in determining the appropriateness of market prices.

5.5 Determining Adequacy of Existing Market Prices as Measures of Economic Value

In practice most analysts tend to accept market prices as proxies for the measures of economic values and only attempt to shadow price major inputs and outputs for which the market price is not considered to be an *adequate* measure of economic value. It should be up to the analyst to show convincing evidence that the magnitude and importance of the difference between a market price and the w.t.p. is great enough to justify the extra effort involved in shadow pricing an input or output. Quite apart from the additional time and funds required to develop shadow prices, there is the danger that inappropriate shadow prices will lead to decisions that, taken in the context of the actual workings of the economy, will be worse for the country than if market prices had been used (which take into account the influences of policies, customs, attitudes, and noneconomic objectives which actually direct the economy).

For any given situation, adequacy of a market price for an input or output depends on (1) the importance of the input or output in the overall project, (2) the estimated degree of discrepancy between market price and w.t.p. or OC for the input or output, and (3) the practicability of developing an acceptable shadow price (which relates centrally to the time and budget available for the economic analysis in each case, and the purpose for the analysis). Each of these three factors is discussed in the following sections.

5.5.1. Estimating the Importance of Inputs or Outputs

Most market priced forestry project outputs contribute to total project benefits, and are potential candidates for shadow pricing.

Many project inputs that can be measured in market prices are relatively insignificant in terms of total costs. Every project involves purchases of a myriad of small items—office supplies, hand tools, etc. Such items generally need not be shadow priced. However, one word of caution is needed here. A project may involve a number of different inputs that individually are unimportant in terms of total cost, but when added together, may have a significant influence on total costs. While it may not be worth the time and effort to shadow price each item individually, it is possible through a sensitivity analysis to test the effect on project outcome of an increase in some or all of the values of these inputs combined (see chapter 7).

Most forestry projects also involve major input items such as land, labor, heavy machinery, processing equipment, etc. Such items may or may not be considered for shadow pricing, depending on time and funds available and the conditions which influence the market prices which exist for them.

As a rough rule of thumb, if an input valued in market price terms represents 5 percent or more of the total present value of the cost of the project, then it is a logical candidate for shadow pricing to determine its economic value. Whether or not it is worth shadow pricing the input depends on the magnitude of the estimated difference between its market price and its economic value (as discussed in the next section). For example, if an item that represents 5 percent of total cost in present value terms has an estimated shadow price that is 20 percent of the market price, then the effect of shadow pricing will be to reduce the cost of that item to only 1 percent of total cost (20 percent of 5 percent) for the economic analysis. This could be significant in terms of a project's economic profitability. On the other hand, if such an item had an estimated shadow price of 90 percent of the market price, then the difference in terms of total cost would only be one-half of one percent (4½ percent rather than 5 percent), which would not be as significant in terms of economic profitability.

Some types of items often listed as inputs can present problems. For example, projects generally include various physical structures, roads, etc. If these have been listed as "inputs" they are likely to be major items in terms of total costs. As pointed out in the previous chapter, such items should be broken down into their component inputs of labor, equipment, various types of materials, etc. In this case, the judgement relates to whether the component inputs are important enough to merit the extra effort involved in developing shadow prices.

5.5.2. Identifying Discrepancies Between Existing Local Market Prices and Economic Values

A shadow price should be developed for an important input or output if there is likely to be substantial discrepancy between its existing market price and its economic value. Such discrepancies can be caused by government policies and other factors.

Discrepancies caused by government policies

Governments use a great number of policy tools to guide their economies toward what are considered to be the economic and social development goals of the country. Common ones include taxes (including tariffs), subsidies, minimum price and price ceiling laws, and quantitative restrictions on market transactions. Of these, only *minimum price* and *price ceiling laws* restrict local price movements and thus affect economic values. Even those policies will cause discrepancies between local market prices and economic values for only some of the input and output categories discussed in section 5.2 (and shown in figures 5.2 and 5.3). It also should be recognized that in many countries policies exist on the books which are, in fact, ineffective and, thus, for analytical purposes they can be disregarded. For example, a government may have placed a price ceiling on lumber for construction. However, if the market price for lumber is below the price ceiling, the price ceiling is ineffective because the price of lumber would be the same with or without the policy or price ceiling. The effectiveness of such policies can be estimated by determining what would happen *with* the policy in place, and what would happen *without* the policy.

Minimum price imposed by government. If a minimum price imposed by a government is effective for a given good or service, then supply would tend to exceed demand for that particular good or service at the established minimum price. If supply does not exceed demand at this price, then the minimum price is an ineffective policy tool, since the market price would settle at the same level with or without the policy (the minimum price).

If a minimum price for a project output is effective—i.e., there is an excess supply of that good or service at the minimum price—it is unlikely that a project would be proposed to add to total supply of that output. Since buyers can obtain as much as they want at the minimum price without the project any addition to total supply would likely remain unutilized so long as the policy remains in effect. Consumption would remain the same with or without the project, so the output of the project would be valued at zero. Of course, if the minimum price is expected to be reduced, then this would have to be taken into account.

Evidence of an effective minimum price policy can be observed by looking at the supply situation for goods and services. Some indications of effective minimum prices are as follows:

- accumulation of stocks when a minimum price is imposed;
- excess capacity coupled with an increase in the minimum price;
- creation of a black market (or informal labor markets where labor is hired below the minimum wage set by government);
- producers abandoning the market because of lack of sales; and
- the existence of unemployment coupled with an effectively enforced minimum wage law. The minimum wage (the *market* wage) is higher than the opportunity cost of labor which should be used in the economic analysis. Caution is needed with this indicator when one is dealing with semicommercialized countries.

Price ceiling imposed by the government. Where a price ceiling imposed by government is effective, buyers will not be able to buy as much as they would like to at the controlled price, i.e., there will be an excess demand at the existing market price. If there were no control on prices, buyers would bid up the market price until the available supply equaled demand at some higher price.

One place to look for evidence of the existence of a price ceiling is the regulatory legislation affecting the marketing of an input or output. However, the mere existence of legislation does not guarantee that price ceiling legislation will be effective. It is necessary, therefore, to look for evidence easily observable in the market that consumption is, in fact, restricted by the government control. Indications of an effective price ceiling policy include the existence of queues, black markets, and various forms of rationing. These are all indicators that the marginal buyer is willing to pay more than the going price for the quantity offered in the market.

The nature and direction of discrepancies between local market prices and economic measures of values caused by effective government controls on local prices (minimum prices and price ceilings) are summarized in table 5.1 for each of the output and input categories shown in figures 5.2 and 5.3. As indicated for several categories of inputs and outputs the policies can either not be effectively applied, or if they are effectively applied, they are not applicable in terms of the measures of economic value used for the particular category of input or output being considered.

This discussion relates to discrepancies between local market prices and economic values which are due to the influence of government policies. Government policies, through the existence of an official fixed exchange rate (OER), can also cause discrepancies between the existing market price for foreign currency (the OER) and the real economic value of foreign currency in terms of what it actually can purchase in the local market in terms of domestic prices. Since several of the output categories (III and IV) in figure 5.2 and input categories (A and B) in figure 5.3 involve use of world market prices (CIF and FOB values) to derive economic values, such discrepancies need to be taken into account if they exist, and foreign currency related effects need to be given shadow prices. A *shadow exchange rate* (SER) is commonly used. It is explained in Ward and Deren (1991).

Table 5.1. Discrepancies between local market prices and economic values caused by effective government controls on local prices.[a]

	Controls on Local Prices	
	Minimum Prices	Price Ceilings
Outputs (see figure 5.2)		
I. Consumer good/service added to total supply	NA	LP <w.t.p.
II. Producer or intermediate good/service added to total supply	NA	LP <w.t.p.
III. Export	NA	NA
IV. Import substitute	NA	NA
V. Domestic supply substitute	NA	NA
Inputs (see figure 5.3)		
A. Imported input—no quota	LP > OC	NA
B. Locally produced input which would have been exported	NA	NA
C1. Locally produced nonexportable input when project induces additional supply	NA	NA
C2. Locally produced nonexportable input when project reduces availability to rest of economy	LP > OC	LP < OC
D. Imported input when quota exists	NA	LP < OC
E. Local resources	LP > OC	LP < OC

[a] LP = local price; w.t.p. = willingness to pay; OC = opportunity cost; NA = not applicable in terms of the appropriate measure of economic value shown in figure 5.2 (outputs) or 5.3 (inputs) or that the policy cannot be effective for the particular type of input or output being considered.

In the case of an identified discrepancy between the OER and the real value of foreign currency in local terms, a general SER is derived and used in all calculations of economic values for inputs and outputs which involve earning, saving or using foreign exchange or foreign currencies. Thus, once the SER has been derived, it can be used for all the categories of inputs and outputs shown in figures 5.2 and 5.3 which directly or indirectly involve foreign exchange (i.e., output categories III and IV and input categories A and B). Not only should a general SER be used to evaluate all such inputs and outputs for a specific project, but it should also be used in analyzing other projects in the country. Thus, estimation of a SER should be done at the national level and used systematically for all projects. This contrasts with the situation for many domestic (nontraded) inputs and outputs. For example, in the case of labor there will likely be shadow prices that are unique to given small areas within a country. If unemployment is high in one area (and mobility of labor is low) then a lower opportunity cost (shadow price) for labor would exist for projects in that area than would exist for labor in other areas with lower unemployment.

Discrepancies caused by other factors

In addition to government policies, other conditions in the project's economic environment can cause discrepancies between existing local market prices and economic values for some input and output categories.[18] The main ones to be considered are

- existence of monopoly or monopsony elements in the markets for project outputs or inputs; and
- existence of speculation or status influences, particularly in the case of land prices.

Monopsony and monopoly. The existence of monopsony power and monopoly power is common in many countries. The power to set prices is a form of monopoly exercised by the government. The distinction made here (in relation to the two categories of policy influences discussed in the previous section) is that this discussion involves monopoly and monopsony power exercised by private (nongovernmental) individuals and/or groups, e.g., corporations or unions. The relationship between the existence of either of these two forms of market control and government policies is often difficult to ascertain, i.e., whether in fact a government is encouraging either or both of them, or it merely permits or condones them in the economy. In some cases, a government is against the existence of monopoly and monopsony in the private sector, but it does not have the political power to do away with them.

The point here, in terms of valuation, is that if monopoly and/or monopsony exist in the project environment and are expected to persist during the period of the project, then their effect should be taken into account when looking at discrepancies between market prices and economic values. For example, if a strong union exists and is expected to persist during the period of the project, then the discrepancy between union set wages and actual opportunity cost of labor should be taken into account in the same way that the discrepancy caused by a government set minimum wage needs to be considered.

MONOPSONY POWER – If one or a few purchasers acting together can alter market prices by modifying their buying policies, then a *monopsony* condition exists.[19] A buyer enjoying some degree of monopsony power will change the market price of the input or output to the buyer's advantage. If the buyer's power is effective, then the price paid by the buyer for the input or output will be somewhat lower than what otherwise would have been paid if the buyer did not have the monopsony power. The market price will reflect only partially the buyer's real willingness to pay.

If there is monopsony power associated with the product (good or service) being produced by the project, or monopsony power associated with the inputs required for the project being analyzed, the same kinds of discrepancies can develop as in the case of price ceiling policies. Thus, the

[18]Note that *existing* market prices are emphasized. In all cases where existing market prices are used as a basis for economic values, a number of factors that will influence projected *future* prices and economic values have to be taken into account.

[19]Strictly speaking, when there are a few purchasers rather than just one controlling a market, economists talk about *oligopsony*. For convenience, the term *monopsony* is used loosely to refer to both situations.

direction of such discrepancies for different categories of inputs and outputs can be identified in column 2 of table 5.1.

Evidence of the existence of monopsony forces can be obtained in some cases by examining sales records. If one buyer dominates the market, then there is good reason to suspect that that buyer is influencing market prices in the buyer's favor. In the case of collusive agreements among several buyers, market influence is much more difficult to identify and to measure. Since these types of arrangements are forbidden by law in most countries, they tend to be made in secret or through informal, tacit understanding among buyers. Generally, when this type of influence is suspected to exist in the market, it can best be considered in a sensitivity analysis, since it is extremely difficult to adjust the market price for this type of effect.

MONOPOLY POWER - If one or a few sellers in a market have the power to influence prices by altering their selling policies, a monopoly condition exists.[20] Whether this monopoly condition will cause a discrepancy between market prices and economic values depends on the type of output or input being valued.

In general discrepancies caused by the existence of monopoly power in the markets for project outputs or inputs will be the same as those shown in column 1 of table 5.1 for government minimum price policies. In other words, monopolists will, in a sense, have the power to set *minimum* prices. On the output side, if a monopolist sets a higher price than previously existed in the market, it will likely influence the volume of sales, since less will be consumed when the price is increased.

On the input side, discrepancies can arise between the local market price and the opportunity cost associated with an input if a monopolist sets the price. For example, in the case of an imported input when no quota on imports exist, a monopolist that controls the local price of imports can set it above the opportunity cost of foreign exchange used to import the input. Similarly, in the case of local resources, say labor, a monopolist (e.g., a union) can set the minimum wage level at a level above the opportunity cost of labor.

Influence of speculation or status on market prices. Prices for land are often set in the market on the basis of speculation concerning future values of land and/or on the basis of status associated with owning land. Such influences can cause a divergence between market prices for land and the value of land in terms of its alternative productive uses (i.e., contribution to real national income). The valuation approach used (see annex 5.2) eliminates the need to be concerned with such divergences. It is suggested that land should always be shadow priced on the basis of its alterative productive uses over the period of the project and not on the basis of land sale prices.

Comments on identifying discrepancies

It is clear that very often the analyst will be able to identify some of the discrepancies discussed and to estimate the direction of the divergence between market prices and economic values, i.e.,

[20]The term *monopoly power* is used to refer to oligopoly (several sellers) as well as the traditional monopoly (one seller) situation.

whether economic values will be higher or lower than existing market prices. However, it is quite a different matter to be able to measure the magnitude of such differences. Even so, the qualitative knowledge does focus attention on those areas where the discrepancy may have a potentially important impact on project worth. Thus, this type of analysis helps to identify areas of uncertainty to be treated later in the sensitivity analysis.

There is one other point which should be mentioned. This relates to *second-round* effects, or discrepancies which exist between market prices and economic values one or more steps removed from the market prices for direct inputs or outputs associated with a project. The discussion of discrepancies has concentrated on only the direct or first-round discrepancies which can be identified. It is quite possible that the analyst will have information on which to judge whether there are discrepancies further down the line which should be taken into account. For example, there may be no apparent policies or other factors which are directly affecting the price of locally produced tractors to cause a discrepancy between the local market price for a tractor and its economic value in terms of the project. However, if it is known that there is a discrepancy between the local market price and the economic value for the steel used in producing the tractor, then an attempt should be made to shadow price the tractor, taking into account the shadow price for steel. While in rare instances it may be possible to make such corrections, generally, from a practical point of view, it will not be possible to trace through all the effects of every input that enters into the production of the inputs used in a project. Normally, the analyst will have to be content to deal with the obvious discrepancies directly associated with the prices for project inputs and outputs.

5.5.3. Ease With Which Acceptable Shadow Prices Can Be Developed

The final factor which needs to be considered in deciding whether to use the market price for an input or output or whether it should be shadow priced relates to the ease with which an acceptable shadow price can be developed (see box 5.3). In nearly all project analyses, the analyst is faced with a time and a budget constraint. The analyst will not have the time to spend on shadow pricing every input or output item which is important and for which a discrepancy is expected between market price and economic value. For many inputs or outputs which are difficult to shadow price, the choice will have to be made between using a rough *guesstimate* of an appropriate shadow price (that at least covers some of the estimated discrepancies between market price and economic value) or using the market price, even though it is recognized to be less than a perfect measure of economic value. (In the latter case, the discrepancy is explicitly acknowledged in the analysis report and alternative values can be tested in the sensitivity analysis.) The choice between these two alternatives will have to be made on the basis of the circumstances surrounding the analysis (its purpose) and the judgement of the analyst as to just how critical the value of the particular item is in terms of the selected measure of economic efficiency.

Finally, for most forestry projects the analyst will encounter indirect effects (externalities or nonmarket priced effects) for which it is difficult, if not impossible, to develop acceptable shadow prices (e.g., in valuing scenic beauty, increases in self-reliance, reduction of drudgery). In such cases, the best the analyst can do is to describe the effects in physical and/or qualitative terms and suggest how they are likely to affect the project outcome and its impact on society.

Some of the practical considerations which influence the decision on whether or not to attempt to shadow price an input or output are discussed in more detail in annexes 5.1 and 6.2.

Box 5.3. Shadow pricing.

In the economic analysis, imperfect prices and costs must be adjusted to reflect an economy in perfect equilibrium, i.e., the imperfections must be removed. If, for example, seedlings are subsidized and costs only LC50 each, whereas the real, unsubsidized price is LC90, the financial cost to the seedling buyer is 50LC. The economic price would be the 90LC, unencumbered by the subsidy. The financial price is the buyer's out-of-pocket cost. The economic price is the society's out-of-pocket cost, of which the seedling buyer pays nly a fraction. Society pays the rest in the form of a subsidy.

As a rule of thumb, the develoment of shadow prices is usally required for

- Anything imported or exported (anything that involves the expenditure of foreign exchange, especially if the exchange rate is artificially pegged).
- Anything subsidized, or bearing fixed prices (any good or service to be used in the project that is currently subsidized such as the production and sale of seedlings in nurseries, etc.).
- Labor, if there is chronic unemployment or underemployment in the country.

Annex 5.1

Shadow Pricing Outputs

Introduction

This annex deals with an approach to shadow pricing outputs for an economic analysis when existing market prices are considered inadequate direct measures of economic value.

As shown in figure 5.2, there are five basic categories of project outputs which can be distinguished for purposes of valuation. These are

1. consumer goods or services which add to total domestic supply available;
2. producer or intermediate goods or services which add to total domestic supply available;
3. output substituting for existing domestic supply;
4. exports; and
5. import substitutes.

The eventual effect in all cases is an increase in the goods and services available for domestic final consumption. However, the appropriate approaches to shadow pricing such increases depend on the category of output being considered and the nature of the links from immediate or direct project output to the increase in availability of domestic consumption goods and/or services. In the case of the first two categories, the relevant measure of value is the w.t.p. for the output of the project. For the third category, the relevant measure of value is based on opportunity cost of the resources released. The last two categories of outputs involve earning or saving foreign exchange. Thus, the relevant measure of benefits is based on what the foreign exchange earned or saved can buy for domestic consumers in terms of local prices, i.e., w.t.p. for imported goods in local price terms. The remainder of this chapter discusses appropriate approaches to deriving these measures of value.

Consumer Goods and Services that Add to Total Domestic Supply

This category of output is often considered to be the most difficult type to value for an economic analysis when the local market price is rejected as a measure value. Fortunately, most forestry project outputs are not final consumer goods that are added to total supply. If they are, then it is frequently found that their existing market prices provide a reasonable approximation of economic value or w.t.p. The main exception is a market priced good or service for which a price ceiling has been set (see below). As mentioned in chapter 5, in cases where a minimum price has been set which creates a discrepancy between market price and w.t.p., it is unlikely that a project will be proposed to add to total supply. This follows from the fact that an effective minimum price is associated with excess supply, so a project would not likely be proposed that would merely increase that excess supply.

The appropriate measure of value for this first category of output is consumers' w.t.p. for the increased output. If the existing market price is judged to be inappropriate as a measure of w.t.p., then the analyst has to try to estimate an approximate schedule of w.t.p. for the output. The usual way is to conduct a survey among prospective consumers (see box A.5.1).

Box A.5.1. Consumer survey limitations.

Two points should be kept in mind concerning consumer surveys. First, in many cases and particularly in those situations where the project affects persons outside the market economy, potential consumers often will not understand monetary values well enough to provide an accurate monetary measure of their w.t.p. for the potential output, particularly considering that the expressed w.t.p. must reflect ability to pay to be meaningful. In other words, if a community family earns a cash income of $50 per year and says it is *willing to pay* $60 per year for, say, fuelwood, this is a meaningless result in terms of an economic efficiency analysis.

Second, experience indicates that w.t.p. surveys sometimes produce biased values, even for consumers within the market economy. For example, even if a family could well afford to pay what it says it is willing to pay, it may not actually do so if the good becomes available. Along the same lines, questions related to how much people would consume at a given price if the output were available sometimes elicit quantity estimates that are different from the quantities that people actually are willing to purchase at that given price. However, despite these potential shortcomings, such surveys may be the only, and therefore best way to get some idea of local w.t.p. Thus, they can be a useful tool.

In some cases a forestry project output will add to total supply of a group of goods which have the same end use (i.e., relate to the same consumption objective). The goods themselves may be different, but the use is the same; thus, they should be considered together. For example, fuelwood and coal may be used interchangeably for fuel by local villagers. A fuelwood project may add to the total supply of fuel available. It may be substituted for coal by local villagers, but the released coal in turn will be added to the supply available for and used by urban and industrial fuel users. If there is no market price established for fuelwood which is acceptable as a measure of economic value for the additional project output, then the market price for coal may provide an acceptable measure of value when appropriately converted to some common measure of fuel/energy value (e.g., calorific value). This would be the case if the market price adequately reflects w.t.p. for coal.

In this case a first reaction might be to value the fuelwood as a substitute for coal. In fact, while the fuelwood is being substituted for coal by villagers, the coal will be used elsewhere, i.e., the total supply of *fuel* available has been increased. Thus, the appropriate measure of value is the w.t.p. for the additional fuel indirectly made available to society by the project. The point is that w.t.p. is based on use or consumption value and there may be several seemingly diverse products which have the same use value. For the purpose of the economic analysis, they are considered together when defining *supply available* and determining whether a project output adds to or substitutes for existing supply.

In the case of a project which would add to total supply of a consumer good or service for which a price ceiling exists, a situation of excess demand may be encountered, i.e., at the prevailing maximum allowable market price, consumers are willing to buy more than suppliers are willing to sell. As indicated in chapter 5, evidence of such a situation (an effective price ceiling) includes the existence of queues, black markets, etc. The black market price can provide an upper limit on the actual w.t.p. for the good, but should generally not be used as a proxy for w.t.p., particularly if the black market is fairly small relative to the total market. Rather, some value in between the administered price (the ceiling price) and the black market price could be used. The best approach in this case is probably to test a number of value assumptions in the sensitivity analysis. If the project produces an acceptable measure of economic profitability using the administered price, then there is less need to consider higher prices (such as the black market price) since they would merely serve to make the project even more profitable (or to increase the measure of economic efficiency).

A final comment relates to the suggestion sometimes made that world market prices can be used as proxy measures of economic value for this category of outputs. Based on the valuation system adopted in EAFP, if for policy or other reasons a market priced good or service could not, or would not be imported in the absence of the project, then its world market price (CIF value) should not be used as a measure of value for it. Similarly, if a good could have been exported, but is produced by the project for domestic consumption, then the export price should not be used as the basis of value for local w.t.p. In this latter case, it can be said that the decisionmakers who decided that the good will be consumed domestically instead of being exported must consider the local consumption value to be at least as great as the export value to the nation. Thus, the export value provides an estimate of the minimum value of the output from the viewpoint of decisionmakers. However, actual w.t.p. by local consumers may be quite different from the decisionmakers' interpretation of the minimum value of the product and it is this local w.t.p. which is relevant.

Intermediate Goods Which Add to Total Domestic Supply

Many forestry project outputs fall in this category. The appropriate measure of value should be based on the relative contribution of the project output to the value of the final consumer goods or services which will be produced with the project output, then such value is measured in terms of consumers' w.t.p. for those final goods or services. For example, lumber produced by a project should be valued on the basis of its contribution to the value of final consumer goods—housing, etc.—which will be produced with the lumber. In practice it is exceedingly difficult and time consuming to develop such a value measure, and this difficulty has led to the common practice of valuing such project outputs on the basis of producers' or *converters* w.t.p. for them, where the converters are those who will take the project output and convert it into final products for consumption.

If there is a local market for such intermediate goods and it is competitive enough to make the price an acceptable reflection of w.t.p. for the output, then there are no problems of shadow pricing. However, if there are administered prices associated with the market or there is evidence of monopsony power on the part of those buying the output or monopoly power on the part of the sellers of the final products to be produced with the project output, then problems arise, for the market price no longer can be taken as an acceptable measure of economic value.

Similarly, in other cases there will be no established market for the project output (i.e., the final processing activities which will use the project output have not yet been established). Thus, there will be no established market price. The best approach in such cases is to evaluate the proposed project as part of a larger integrated project which would include everything up through the final production of consumers goods. For example, if the initial project were defined as one to produce pulpwood for a proposed pulp and paper mill, and there is no other market for pulpwood, then the pulpwood output could be considered as an intermediate input (cost) in an overall project (pulpwood, pulp and paper project) and the pulpwood could be valued as an input on the basis of the opportunity costs involved in producing it (see annex 5.2).

The analyst also could attempt to survey converters' w.t.p. for the project output. Such surveys are fraught with various difficulties similar to those mentioned for consumer surveys. The problems are even more difficult if the project output will not be sold competitively, since converters or producers of the final goods are not likely to reveal their true w.t.p. if they realize that they will be the only ones buying the output. Yet, under the circumstances, this type of survey coupled with judgement on the part of the analyst may provide the best information possible.

Another common approach used in financial analyses of forestry projects is to calculate a ***surplus value*** for the intermediate output and then attribute that value to the project producing the intermediate output. The surplus value is derived by estimating the final product price and then subtracting all costs other than the value of the project output (which will be an input in production of the final product). The amount left after these subtractions is then divided between profit and the surplus value to be attributed to the project output. This approach can provide an approximation of what the producer of the final product could afford to pay for the project output and still make an acceptable return or profit. (In calculating the surplus value, allowance should be made for a profit element, usually equal to the going rate of return on similar types of investments.) In the absence of other means for approximating values, and if it is not possible to combine the proposed project with the further processing stages so the total integrated operation is treated as a whole, then the surplus value approach can at least provide some order of magnitude estimate of value.

It should be emphasized that the process of calculating a surplus value can be extremely difficult and time-consuming and also is fraught with potential errors if adequate information is not available on the economic value of the final product and all the intermediate costs down to the proposed intermediate output of the project being analyzed. For example, in the pulpwood plantation project mentioned earlier it would be necessary to develop an estimate of the value of the final paper production, estimates of all the costs involved in producing it and an estimate of the normal profit which could be expected. If there is no paper production in the country, then these estimates can only be derived by going through a complete economic analysis of the proposed pulp and paper project, in which case, an evaluation of both the pulp and paper project and the plantation project as an integrated whole might be done.

Output Substituting for Existing Domestic Supply

In this case, total supply available remains the same. The project would substitute for another domestic source of supply, which, when curtailed, would release resources for other uses (production of other goods and services). It is consumers' w.t.p. for these other goods and services (which would not have been produced in the absence of the project) that is used as a measure of value of the project to society.

This approach is quite different to the one for an output which increases supply. In a project that adds to total supply, it is the w.t.p. for the additional output of the project itself that is relevant.

In a project that involves substitution, the relevant comparison is between the opportunity costs of alternative sources of the same output, since with or without the project the total amount of the good or service would be the same.

In some cases tracing the relevant substitution impact of a project can be a difficult process (see boxes A.5.2 through A.5.5).

Box A.5.2. Proxy values based on substitution: Example 1.

Example 1. Assume a situation where a fuelwood project output would partly substitute for noncommercial fuels, such as animal dung and crop residues which would be used for fuel in the absence of the project. Assume further that if these alternative fuels were left on the land they would increase the value of agricultural crops because of their properties as soil builders and fertilizers. In this case the net value of the increase in crop output or the value of crop losses avoided (i.e., *with* and *without* leaving the dung and residues on the land) can provide a measure of the benefits of the project. The fuelwood is considered as an indirect substitute for fertilizer and soil builders, and its value is determined by the value of these resources released and now available for agricultural production.

This value is being used as a measure of w.t.p. in the sense that it is assumed that farmers would be willing to pay to the fuel gatherers an amount up to the value of the crop loss avoided, say $20/ha, if the gatherers would leave the dung and crop residues on the fields. In turn, if these gatherers were given this amount of money, they would be willing to pay up to this amount to buy fuelwood with the same calorific value as the dung and residues left on the ground. Both farmers and gatherers would be just as well off as before. But crop consumers would be $20 better off, assuming that this value of crop loss avoided is based on consumer's w.t.p. for the crop. Thus, this is the benefit. An example shown in the table below.

Derivation of shadow price for project fuelwood substituting for crop residues.*

Basic Information:	
Crop residues removed per ha/year (a)	2 tons
Corn crop value increase per ha/a if residues left on fields	$20
Heating value of 2 tons crop residues	376,000 kilocalories (kcal)
Heating value, $1m^3$ of project fuelwood	188,000 kcal
Calculation of fuelwood shadow price:	
Heating value of $1m^3$ of project fuelwood =	heating value of 1 ton of crop residues
Corn crop value increase due to 1 ton of crop residue =	$\frac{\$20}{2} = \$10$
Value of $1m^3$ of fuelwood =	$10

* Hypothetical example.

Many projects may involve both substitution and additions to total supply of consumption. For example, there may be an increase in the consumption of fuel because a fuelwood project provides it at a lower financial cost to the consumer than the price of the present fuel (the one for which the fuelwood will substitute). In this case, the two components have to be separated—the substitution part and the increase in total supply part—and each has to be appropriately valued according to the guidelines above. Suppose, in a case where fuelwood substitutes for coal, that without the fuelwood plantation project one million calories per day is consumed now using coal and that with the project, because of a lower financial price put on plantation fuelwood, consumption increases to 1.2 million calories per day. Substitution of fuelwood for the 1 million calories could be valued on the basis of the opportunity cost for

Box A.5.3. Proxy values based on substitution: Example 2.

Example 2. Assume that a project is being proposed to establish fuelwood plantations for a local community. The output would substitute for fuelwood presently being collected by local community members from natural forests on surrounding hillsides.

At the present time (without the project) village families have to spend time gathering fuelwood from natural forests some distance from their homes. If there is alternative productive work available for these families, then they have to give up the income from such alternative work in order to get the fuelwood, and society gives up the income the fuelwood gatherers could have produced by working in alternative employment. This income given up (or the benefits society gives up) provides an estimate of the value of fuelwood. For example, suppose that a given family takes two days a week to gather its weekly fuelwood requirements of 20 kg and that the family members involved in the gathering would have produced a total of $2.00 in alternative work (either producing food for home consumption of in the employ of someone else) if they did not have to gather the fuelwood. This $2.00 that they give up would provide an estimate of their w.t.p. for the fuelwood, or the value to society of the resources saved.

In order to use this approach the analyst has to accept the assumptions that

- the value to the fuelwood gatherer of additional fuelwood (beyond 20 kg in the case of the example) is not worth the additional income s/he would have to give up by going out to collect more fuel. In other words, the value of an additional unit of fuelwood to the gatherer is just equal to the value of the income s/he would have to give up to collect it. If it were more, then the gatherer would go out and collect more fuel (and give up income). If it were worth less, then the gatherer would give up an additional unit of fuelwood and work more;
- the value of each unit of fuelwood consumed is the same to the gatherer. In fact, this assumption is common to all the valuation approaches suggested. While the first units consumed are likely to have a higher value than the last, there generally is no practical way of taking this into account quantitatively. Thus, the assumption is made that all units will have equal value and that this will be equal to the estimated value of the last unit. The result in most cases is a tendency to understate the real value of (or w.p.t. for) the total output. (This issue—and a confirmation of the fact that it is almost impossible to deal with it in practical valuation problems—is amply discussed in the literature under the heading of *consumer surplus*.)*

* Cf. USDA Economic Research Service, October 1977. It is stated, for example, that "dissatisfaction among economists about the usefulness of consumer's surplus has brought outright condemnation by Samuelson ... who remarks: 'The subject is of historical and doctrinal interest, with a limited amount of appeal as a purely mathematical puzzle.'" (p. 117).

production of the coal for which the wood is substituting. However, the additional consumption—200,000 calories per day—should be valued on the basis of the consumer's w.t.p. for the additional consumption, since it is adding to total supply and not substituting for the domestic coal. It is only being consumed because the financial price is lower for the fuelwood. The w.t.p. for it (its economic value) is also likely to be lower.

To summarize, for a category of output that will substitute for other domestic supply of the same product or another product with the same use value, the appropriate measure of value of the benefits due to the project is the opportunity cost of the resources released, or the value of what these resources would produce if they were released. If the resources released have no other use, then the value of the project output may be zero or close to it. On the other hand, if the resources released are otherwise fully employed in the economy, and they are traded in a fairly competitive market, then the prices of the resources released provide an adequate

Box A.5.4. Proxy values based on substitution: Example 3.

To take another example, assume that the family members involved in the fuelwood gathering have no alternative productive uses for their time. Does this mean that the proposed plantation fuelwood should be valued at $0? So long as there is fuelwood available for families to collect elsewhere, then an appropriate measure of value for the plantation output may be close to $0 from an economic efficiency point of view.* It would not likely be zero since fuelwood collection may involve a higher food intake than complete idleness, i.e., the collectors must have a higher calorie intake for them to be able physically to carry out the arduous task of collecting the wood. If the family is willing to incur this additional *cost* then the value of the fuelwood is at least equal to this cost, i.e., it is above zero. Similarly there may be health and fatigue costs. However, these are difficult to measure and value. Normally, they are merely described qualitatively in project reports.

Even if the value of the alternative uses of fuelwood gatherers' time is zero, there may be some benefits associated with a fuelwood project that permits natural vegetation to remain on areas that should be protected to prevent erosion or to provide habitat for wildlife (food). To the extent that these benefits can be quantified and valued, they should be included. If they cannot be valued, they should at least be treated explicitly in qualitative or physical quantitative terms in the analysis document.

Finally, it may be that while the local families can currently go out and collect fuelwood, scarcity of wood is increasing (e.g., as indicated by increasing amounts of time required to collect fuelwood). If this is the case, then the analyst has to allow for this changing situation in the analysis (by applying the with and without concept). If the families are likely to have increasing opportunity costs over time, then the analyst can value future project output on this basis. For example, the one day of fuelwood gathering per week required now may not carry any opportunity cost, but if the time required is expected to increase to three days, then the family's home food production may suffer and this could constitute a basis for attributing a positive benefit to a fuelwood plantation project that would avoid this loss of home food production.

* It is emphasized that efficiency is not the only concern in the economic analysis. The project may have value on the basis that it reduces the drudgery and toil of people (i.e., reduces *costs*), which was labelled in chapter 2 as a legitimate goal for a project.

Box A.5.5. Proxy values based on opportunity cost and expanded consumption.

As another example, assume a project designed to improve a forest road so that hauling/transport costs for logs delivered to mills can be reduced. Part of the benefits can be measured in terms of the costs saved for the volume of wood that normally would travel over the road. In other words, as in the typical substitution project, the new road releases resources which had been used in transporting wood and which now can be used in other activities (production of other goods and services). This part of the benefits is appropriately valued on the basis of the opportunity cost of the resources released. However, it is also possible that the improved road results in an expansion of wood output. The logic is as follows. With lower transport costs, total production costs decrease. Producers of the wood products, if dealing in a somewhat competitive market, will tend to lower prices as their costs go down. With lower prices, consumers will be willing to purchase more. Thus, the project also has resulted in an expansion of consumption of the products being produced. The net increase in the value of the expanded consumption (i.e., net of additional costs) can be attributed to the project as a benefit. Since this part of the output adds to total supply, it has to be valued as suggested earlier, depending upon whether the expanded supply involves a direct consumer good or an intermediate producer good.

approximation of the value of the project output. In between there will be cases where some of the resources released will have alternative uses and some will not.

The analyst's task is to identify the various inputs released and then to determine their alternative use values or their opportunity costs. Finally, if the proposed project output, say lumber, will substitute for other domestic lumber supply, and that other supply will now be exported, then the project output is treated as an export output for valuation purposes (see following section).

Exports

In this case the relevant measure of value is the local w.t.p. for the goods and services which will be purchased with the foreign currency earned. The foreign currency earned is reflected in the FOB value for the exports. If there is a free market exchange rate and no tariffs or subsidies attached to goods or services which will be imported with the foreign currency earned through the project, then the FOB value expressed in foreign currency (say dollars) can be converted to local currency using the market exchange rate that is expected to exist at the time the project output is exported.

However, in reality there will seldom be a situation where there is a free exchange rate and no tariffs or subsidies. This means that something other than the existing exchange rate has to be used to convert the FOB value to local w.t.p. terms. For this purpose a shadow exchange rate (SER) can be used.

The shadow exchange rate (SER)

Before suggesting guidelines for the use of a SER, it is necessary to look at how it is derived by national planners. The SER is defined as the real purchasing power of a unit of foreign currency expressed in local market price terms. It measures the average difference between local prices including tariffs and subsidies and prices calculated using the existing exchange rate, i.e., the average level of price distortion caused by tariff barriers. In an economic analysis the analyst is interested in actual w.t.p. or opportunity cost in local price terms. Therefore, the influences of tariffs and subsidies have to be included in the estimates. Sometimes the SER is adjusted to reflect nontariff barriers, e.g., import and export quotas and controls on buying and selling foreign exchange.

The SER is generally calculated to reflect the average price distortion in the economy, considering all imports and exports.

Some guidelines for forestry project planners follow. As mentioned in chapter 6, the SER used in a country should be a general one that reflects the entire trade picture and the average tariff or trade barrier effect on trade, where the average is calculated as a weighted average of all tariffs and subsidies on trade (i.e., tariffs and subsidies weighted by the amount of the trade to which they apply). Thus, it should be calculated by national planners for use in all project analyses in the country.

If such a national SER is available, it is recommended that analyst use it. If the analyst believes that s/he has a strong case for modifying the SER imposed by the Central Planning body, s/he

Box A.5.6. Values considering tariff distortions.

For example, assume a country situation where the existing exchange rate is set at 10 units of local currency (LC) per unit of foreign currency (say $). The average level of import tariffs and export subsidies (treated as *negative* tariffs) is calculated to be 10 percent. Simplifying somewhat, it can be assumed that the local currency is actually overvalued by 10 percent by the existing exchange rate. While officially the local price of foreign currency, or the rate of exchange is LC10 per $1, in fact, when people go to buy foreign goods in the local market, they pay on the average 10 percent more (because of the import tariffs) or LC11 per dollar worth of imported foreign goods. The SER in this case is 11 to 1 in contrast with the existing rate of 10 to 1. Similarly in the case of exports. Assume a project that earns $100 by exporting lumber. In terms of local currency converted at the existing exchange rate of LC10 per $, the benefits of the project would be $100 x LC10 or LC1,000. In fact, given the average tariff distortion of 10 percent, goods and services can be bought with $100 that are worth $100 x LC11, or LC1,100 in terms of local w.t.p. Thus, in terms of the economic analysis, the benefits of the project in terms of local w.t.p. in local prices should be LC1,100 rather than LC1,000.

can try to persuade this body to change it. Until it is changed, the analyst should use the given SER. In any case, the analyst can develop a test of sensitivity of the project to potential alterations in the SER.

If a generally accepted SER is not available in the country (developed by the national planning office or some other national planning body), then the existing exchange rate can be used. The analyst of forestry projects should generally not try to develop a SER of the analyst's own, since the task is quite complex, and if it is not done correctly, it could easily lead to distortions and to results which are not comparable with those for other projects. However, the analyst should test the sensitivity of the project results to alternative rates considered to be closer to the actual w.t.p. than the existing rate of exchange.

An alternative way to adjust the relative prices of traded and nontraded goods is to use a *standard conversion factor* (SCF). The SCF is equal to the official exchange rate divided by the SER (or 1 divided by 1 plus the foreign exchange premium expressed in decimal terms). The key point to note here is that both the SER and SCF valuation procedures generate the same relative net present worths; and the internal rates of return do not change. Project selection based on profitability of alternatives results in the same relative rankings for projects (see Ward and Deren [1991] for a comparison of the two approaches).

Valuing exports using FOB values and the SER

As mentioned earlier, the gross amount of foreign currency earned by an export project is measured by the FOB price for the output times the volume of output. In other words, the FOB price becomes the unit value of the export output expressed in foreign currency. Since local w.t.p. for goods and services expressed in local currency is being used to measure economic value, the foreign currency has to be converted to w.t.p. for what the foreign currency can buy in terms of local prices expressed in local currency. This is done by multiplying the FOB value by the SER.

In deriving the FOB value the market to which output will be exported can be determined, and using the CIF price in that market the FOB value for the output at the port of export can be derived. Obviously, if a FOB value already exists at the port of export, that value can be used. If several possible markets are being considered, then the FOB values associated with each can be derived, and if they differ, the highest can be picked under the assumption that exports would go to the most profitable market. If the output is intended for several specific markets and they result in different FOB values, then a weighted average FOB value can be used, basing the weights on the proportion of output that will go to each market.

Projects that indirectly result in increased exports can also be considered in this category. For example, assume that the project output of sawnwood will replace other locally-produced sawnwood in the local market and this other sawnwood will now be exported. In this case, the FOB value still provides the relevant basis for measuring benefits, since the project will result in an increase in the nation's exports which will permit expanded imports of other goods and services. Applying the with and without test, the shadow priced foreign exchange value of the exports is the relevant measure of value for the benefits due to the project.

Import Substitutes

If the project output will substitute for imports which actually would have taken place in the absence of the project, then the correct basis for valuing the output is the foreign exchange savings made possible by the project. The CIF price in foreign currency of the substituted imports is multiplied by the SER to obtain the local w.t.p. value, just as in the case of exports.

The project output may also substitute for another completely different imported product which has the same use. In this case, the project output can be valued on the basis of the CIF price for the other product times the SER, when appropriate adjustments have been made to equate the use-value of the project output with that of the other product.

For example, assume that project fuelwood will substitute for imported kerosene. In this case, the CIF price for the imported kerosene for which the fuelwood will substitute can be used to derive the shadow price for the fuelwood, by converting fuelwood and the imported kerosene to a common basis, e.g., cost/kilocalorie. An example is given in box A.5.7.

Avoiding Some Potential Output Valuation Errors

Several of the valuation approaches suggested are based on the assumption that a project's output will substitute for some other good or service. In using this approach the analyst should pay particular attention to the following questions:

- are the goods indeed substitutable technically and in terms of consumer preferences?
- if they are, will the assumed level of consumption (substitution) actually take place?

With regard to the first question, the analyst can draw on technical information and perhaps carry out a survey of consumer willingness and ability to substitute the two products. For example, some cooking and heating systems might be able to burn kerosene but not be properly designed for wood. In this case, the analyst looking at a fuelwood project that would substitute wood for

Box A.5.7. Estimating project output value on the basis of the value of another product for which it will substitute.

Project output:	Fuelwood
Substitute product:	Kerosene, now imported with an estimated CIF price of $.40/litre (I)
Calorific values:	Kerosene: 3,200 kcal/l (burnt at 35% efficiency) Air-dry wood: 188,000 kcal/m^3 (burnt at 8% efficiency)
Inputed substitution for wood:	$\frac{(\$/m^3)}{188{,}000 \text{ kcal}} = \frac{\$.40}{3{,}200 \text{ kcal}}$ or $(\$/m^3) = \frac{(188{,}000 \times \$.40)}{3{,}200}$ $(\$/m^3) = \$23.50$ (This value could be used for the fuelwood if it is actually going to substitute for imported kerosene. It would be converted to local currency equivalent using the SER.)

kerosene would either have to doubt substitutability or suggest to the project planner that the project also include a component for redesign or remodelling of cooking/heating systems, if such is not already included. At the same time the analyst would also want to check very carefully the substitutability of wood for kerosene in terms of some common heating and/or cooking values. Such measures may be calories per unit volume or weight, or it may be in terms of less accurate measures such as *average* amounts needed to cook common foods or to provide heat in homes, etc.

The same type of considerations would be necessary in looking at the substitutability of lumber or plywood for other building materials, domestic paper production for imported paper, etc.

The last point brings up the second question raised. Assume that it is found that the marine plywood would be substituted for the interior plywood that had been used in exterior uses. Would the same quantity be consumed? This would likely depend on the actual pricing policy adopted for the project output (i.e., a financial consideration). If it were to be sold at the same price as the interior plywood, it might be substituted in equal quantities. But if the price were to be higher (because cost would be higher), then volume would likely be lower. In this case, the analyst has to watch the assumption about quantities of project output that would actually be directly substituted for interior plywood. Similarly, if it is to be sold at a subsidized price below the price of the substitute, volume may increase (see box A.5.8).

Finally, it should be reemphasized (as was done in chapter 5) that relative values often change over time, i.e., the value estimated for an output today may not be the relevant or appropriate value for some future period, even after taking out the influence of expected general price inflation. Thus, to the extent possible, the analyst should attempt to estimate what likely changes in output values still take place over time due to the same types of factors discussed for market prices in chapter 5. It is often difficult to project values into the future. There is uncertainty and

Box A.5.8. Linkages between projects.

For example, a domestic newsprint project is proposed, based on the use of mixed tropical hardwoods. The resulting newsprint would have different quality characteristics than the imported newsprint for which it would supposedly substitute. Is it valid to use the price of imported newsprint to value the domestic (project) output? That will depend on whether the project output would be acceptable as a direct substitute in terms of use. Or assume a project to produce exterior or marine plywood intended as a substitute for nontreated interior plywood that is being used for exterior uses at present. In this case, the price of the local interior plywood would not be an adequate measure of the value of the project output, since the life (use value) of the two products would be quite different. Thus, the replacement rate over time would be different. A consumer w.t.p. survey would have to establish whether consumers would be willing to pay more for the better use value of the marine plywood. Such a survey would have to establish price-quantity relationships. This type of survey would be needed, in any case, as part of the market study for the financial analysis, so the additional effort for the economic analysis would be slight.

many unquantifiable variables involved. Often the best thing to do is to assume constant relative values over time and then test the sensitivity of project results to potential changes in values. This is discussed further in chapter 6, which deals with the treatment of uncertainty.

Annex 5.2

Shadow Pricing Inputs

Introduction

This annex deals with approaches to shadow pricing project inputs. As shown in figure 5.3, inputs can be classified into five main categories for the purposes of empirical estimation of shadow prices

1. inputs that are imported when no quota exists on imports;
2. locally produced inputs which would have been exported if not used in the project;
3. locally produced nonexportable inputs;
4. imported inputs when a quota on imports exists; and
5. resources (land and labor).

Each of these categories is discussed separately in the following sections. As in the case of outputs there are several categories of inputs that involve foreign exchange effects. The SER, as discussed in chapter 5, is used to value such inputs. Specific uses of the SER are discussed below where they are needed.

Imported Inputs When No Quota Exists

Imported inputs not limited by any quota are valued on the basis of the local value of the foreign currency required to import them. This is measured in terms of the CIF value for the input times the SER. There are two exceptions to this approach

1. In some cases, inputs are financed by a grant which is tied to the project, i.e., a grant which only can be spent on importing the input for its exclusive use in the project. If this is the case, then there is no difference in total foreign exchange availability for other uses with or without the project. Therefore, no alternative benefits are sacrificed by using foreign exchange in importing the input. The economic cost to the domestic economy of the input financed by a tied grant is equal to zero.

2. When the input is financed with a tied loan, the economic cost does not materialize when the input is paid for (imported), since there is no alternative use permitted (no opportunity cost) for the foreign loan. The cost occurs at the time of repayment of the loan, when alternative imports could have been financed with the foreign exchange used up in paying the debt (principal plus interest).

Exportable Locally Produced Inputs

If the input used by the project actually would have been exported in the absence of the project, then the value foregone by the economy by using the input in the project is represented by the reduction in the availability of foreign exchange. The domestic w.t.p. for the imported goods and services foregone is the correct measure of the economic cost of using the input in the project. The basis for this value is the FOB price of the input (the foreign currency earnings foregone) converted to local prices of imported goods/services using the SER.

Nonexportable Locally Produced Inputs

The appropriate value measure for a nonexportable locally produced input (i.e., an input for which local production cost is greater than FOB value or where prohibited by government policy) is related to whether or not use of the input in the project reduces total supply of the input available to the economy (see input categories C1 and C2 in figure 5.3).

- If the project's use of the input reduces total supply of the input available to the rest of the economy, then the relevant shadow price of the input is based on the net benefits which are sacrificed (i.e., opportunity cost) in using the input in the project rather than in the next-best alternative use.
- If the project use of the input induces additional local production of the input, then the relevant cost is measured in terms of the value of the resources used up in increasing the supply of the input, i.e., their opportunity costs.

Note that if use of the input in the project induces additional or new imports of the input for use elsewhere in the economy, then the input can be treated as an imported input for valuation purposes, i.e., the foreign currency cost (CIF value) becomes the relevant measure of economic value when converted to local prices using the SER. (This parallels the case of a local consumed project output which induces exports of the same product from other producers.)

Imported Input For Which a Quota Exists

If there is an import quota affecting an imported input, its value should be measured in terms of the w.t.p. for its contribution to the value of alternative outputs that would have been produced with the input elsewhere in the economy if the project were not implemented. The reasoning is that the total amount of input allowed by the quota would have been imported with or without the project and, therefore, in these circumstances there would be no net drain of foreign exchange induced by the project. If imports of the input are below the quota, then the quota is ineffective and, from the point of view of the analysis, it does not exist. Thus, the input's CIF value could be used as a basis for valuing the input.

Resources: Labor

The objective in valuing labor is to arrive at a measure of the value of the benefits foregone by employing labor in the project rather than in its next best alternative use. If labor is hired away from other productive work and there is little unemployment in the project region, the value of the labor in the other work, or the market wage, provides an acceptable measure of opportunity cost for the economic analysis. This section discusses situations where these conditions do not hold, i.e., the market wage does not adequately reflect opportunity cost.

Unskilled labor

The main questions of interest in shadow pricing unskilled labor relate to the following situations:

1. *Labor hired in the project is from the pool of unemployed persons in the project region.* The value of these unemployed workers is equal to the production foregone by putting them in the project. If they were producing food or materials at home for their own consumption, and they have to give this up when they work in the project, then the value of what they give up is an appropriate measure of opportunity cost. If they were producing nothing (which is an exceptional case), then a shadow price close to zero can be used. The cost will probably never reach zero since there is generally some cost involved in training, housing or otherwise taking care of unskilled labor that has been unemployed for some time. This cost has to be added in somewhere in the accounts as a cost.

2. *Labor hired in the project is taken from other productive jobs, but there is unemployment in the project region (i.e., persons willing and able to work in paid jobs).* In this case the assumption generally adopted is that even if the project merely hires workers away from other jobs, these other now vacant jobs will then absorb new workers from the pool of the unemployed. Thus, the project will result indirectly in a reduction in unemployment and the labor used in the project should thus be valued in the same way as for (1). Application of the with and without test demonstrates the logic of this approach.

3. *Labor is hired only part-time in the project.* In the case of unskilled seasonal labor, it is generally desirable to take into account general periods of seasonal employment and unemployment. First, the analyst can determine by observation, or from records, the periods of general seasonal employment existing in the market area for the labor that will be used in the project. The analyst can then compare these periods with the periods during which temporary employment is required by the project. To the extent that the two periods do not overlap, the analyst can use the shadow wage for unemployed labor as derived above in valuing seasonally unskilled labor employed in the project, since, by definition, such labor is unemployed during the off-season. However, if the project's requirements overlap with the general period of seasonal employment (for crop harvest, planting, etc.), and if there is no general unemployment during the period of seasonal employment, then the analyst has to attribute a shadow price for seasonal labor employed in the project equal to the actual wage paid for seasonal labor in the regional economy.

A case study from Korea indicates how this was done in the case of fuelwood plantation project.[21] Since the fuelwood labor requirements overlapped somewhat with the seasonal requirements for agriculture, an average shadow wage rate based on the full seasonal wage rate and the off-season income (monetary and in-kind) of unskilled village labor was used as the shadow wage rate. The weighting was based on the proportion of project employment which overlapped with the period of general seasonal full employment.

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[21] Case Study no. 2, FAO (1979).

In handling these three types of situations it is necessary to look at the nature of the market and distinguish between unemployment in an economic sense and unemployment in the sense that it appears that people are *doing nothing*. In an economic analysis it is unemployment in an economic sense that matters. This is determined by both supply and demand. As an example, assume a situation as indicated in box A.5.9.

Box A.5.9. Shadow pricing unemployed labor.

In the project region there are some 1,000 persons in the unskilled labor category presently employed. About 100 persons are *unemployed* in the sense that they are not working in paid jobs (i.e., receiving wages). The project will require ten full-time unskilled workers. How should they be shadow priced? The answer depends partly upon what the apparently unemployed workers are willing to work for (i.e., what they give up by going to work in the project). It may very well be that they are producing at home for their own consumption. If they go to work in the project they may have to give up this production (consumption). If there is a competitive labor market (and no minimum wage set by government or unions), then there is no unemployment in an economic sense. Those who are not working feel that spending their time doing other things is worth at least as much as the minimum wage paid in the competitive market. Thus, this minimum wage would provide a reasonable measure of labor value (or opportunity cost for labor) at the margin.

In cases where unemployment exists due to some policy and/or regulation of minimum wages, a shadow wage rate based on alternative production foregone has to be ascertained, and this will likely be lower than the regulated minimum market wage. For example, if a government-set minimum wage is in effect, it may be possible to locate an *informal* competitive labor market in rural areas where the actual wage paid is below the set minimum. This would provide an approximation of the appropriate shadow wage rate. If no informal market can be located, then the analyst will have to rely on rough estimates of what the unemployed would give up in terms of other production if they were employed in the project. This information might be obtained from surveys of local community households.

Confusion sometimes arises if the unemployed who will now be employed in the project are receiving unemployment payments (benefits) while they are unemployed. This type of payment is a transfer payment, or a transfer of consumption from some members of society to others. While it is relevant in a financial analysis carried out from the government's point of view, it will not be relevant in the economic analysis, where the analyst is attempting to estimate the opportunity cost of labor, or the value of consumption foregone by employment labor in the project being analyzed.

Professional and skilled employees

Professional and skilled employees are required by most projects. In many developing countries there is an acute shortage of this type of employee. It is also common in these countries that the government imposes wage and salary increase limits (salary ceilings). As in all cases where an effective maximum price is imposed, the result is that the willingness of employers to pay the skilled labor might be higher than the current salary level. Skilled persons may be fully employed, but they are being paid less than the producers are prepared to pay, i.e., their real opportunity cost. In such cases the analyst may wish to use a shadow wage or salary level above the market level.

If skilled or professional labor is unemployed in the economy, then it can be treated in exactly the same way as unemployed unskilled labor, i.e., valued on the basis of its opportunity cost without the project.

Resources: Land

The appropriate measure of value for land is the highest net return that actually would have been obtained from the land in the absence of the project. The analyst thus needs to estimate what the net return would be from the best actual alternative use. This the analyst uses as the shadow price for land.

In estimating the opportunity cost of land, the analyst can use information obtained from interviews and data on land use in the project region, particularly as such relate to land availability and uses of land similar to the proposed project lands.

In valuing land, the analyst should guard against overvaluation of land cost due to

- attributing to the land a net value from alternative use which will be obtained from some otherwise idle area if the project is implemented;
- ignoring the fact that in some cases an alternative use which would take place in the absence of the project would not continue over the entire project period; and
- forgetting to subtract all costs (other than land) needed to obtain the gross benefits from the best alternative use (i.e., it is the net value foregone which is the relevant opportunity cost).

Each of these points is discussed in greater detail in the following paragraphs.

In many cases, there are few actual alternative uses for lands devoted to forestry projects. This may be because of the low quality of the land for other uses, but it also may be because there is no land pressure in the project area and abundant other lands exist to accommodate other potential uses (see box A.5.10).

Box A.5.10. Shadow pricing land: Example 1.

For example, suppose there are two large idle land areas, A and B. It is proposed to put area A into the forestry project. Cattle production in the project region is expanding. The analyst estimates that the project area could support a net return from grazing of $10/ha/a over the project life. So could area B. If idle area B will likely absorb the foreseeable demand for such grazing land over the life of the project, if the project is undertaken, then there is no cost to society by putting land area A into project use and using area B for the grazing expansion. Thus, the opportunity cost of putting the land into project use would be zero. On the other hand, if the foreseeable expansion of grazing would require more than area B—i.e., if demand for area A is anticipated over the project life—then some cost would have to be attributed to the land area A put into project use, since some net grazing value would be foregone. The timing of this opportunity cost would have to be adjusted to the time when A actually would be needed.

Another potential overvaluation error to avoid relates to the assumption that a piece of land considered for a forestry project will have an alternative use which will continue to be viable over the entire project period (see box A.5.11).

Box A.5.11. Shadow pricing land: Example 2.

Consider the case of a tropical land area having poor soils. There may be an immediate alternative annual crop value that would have been obtained in the absence of the project. If such an alternative use would have taken place, then this is an appropriate value to consider for the period during which the use would take place. However, someone knowing little about tropical soils may suggest that the estimated initial annual net crop value foregone should be used as a cost during every year of the forestry project's life—say 15 years in this example. In general, for most tropical soils and environmental conditions, it will not be possible to have continuous production of annual food crops on the same land without introducing drastic measures, including very heavy applications of fertilizer which would increase costs and reduce potential net returns (i.e., the opportunity cost). The cost of such fertilizer and other treatments could result in the net value of the crop (the opportunity cost) reaching zero after only a few years of initial production. To shadow price land correctly the analyst might develop a shadow pricing schedule for the land such as shown in the hypothetical figures in the table below. Note that the calculations would give quite a different answer if it were merely assumed that the opportunity cost per year would be the same over the entire life of the project and equal to the opportunity cost in the first year.

Schedule of net crop value foregone for use in shadow pricing land.*

Year	Shadow price based on annual net food crop value foregone ($/ha)
0	$75
1	$75
2	$70 - productivity starting to decrease
3	$65
4	$50 - heavy fertilizer application
•	•
•	•
9	$0 - value of required fertilizer is equal to net crop value increment
10	$0 - all nutrients removed; soil has essentially become sterile and of no further use for annual crop production
•	•
•	
•	
n (end of project)	

* Hypothetical data.

A third potential overvaluation error relates to what is included in the opportunity cost calculations. It is the net value foregone which is relevant as an opportunity cost, not the total value of the output foregone. Thus, in a particular situation, a plantation project may be taking land out of crop production where the total or gross value of the crop foregone is $100/ha/a. To get an appropriate shadow price for the land, the analyst would have to subtract all the costs (other than land) required to bring forth that $100 of gross value. It may be, because of a depressed price due to oversupply of the crop that the costs would be equal to the $100 of gross value, in which case the opportunity cost of the land would be zero in terms of the forestry project. Society would not be giving up any net consumption benefits, since the costs would equal the benefits and the net value foregone would be zero.

Changes in Shadow Prices Over Time

As indicated in chapter 5, when market prices are used as a basis for shadow pricing, the analyst should keep in mind that the opportunity costs associated with inputs may change over the life of the project. Such expected changes have to be taken into account.

Similarly, in situations where there is some indication that the employment situation existing at the beginning of the project will not hold over the entire project period, e.g., unemployment is expected to decrease due to general improvement in economic conditions even without the project, the analyst may wish to make adjustments in the shadow wage rate for latter years of the project. Again, this remains a matter of judgement. If the situation is very uncertain, the analyst may merely wish to consider such possibilities in the sensitivity analysis.

Box A.5.12. Shadow prices shifting over time.

For example, in the case of land, although there are no apparent alternative uses for the land at the time of appraisal of the project, such uses may easily develop during the project period. Thus, a land cost should be included for the appropriate period. In a typical forestry project, the period of time involved can be substantial—say 20 years or more. Thus, the analyst should be concerned with what developments in the region would likely take place in the future which would make the land valuable for other uses during the project period. For example, even slight shifts in agricultural prices can make previously idle land attractive for agricultural production or livestock grazing, i.e., move the opportunity cost from zero to some positive value. To the extent possible, following the with and without principle, the analyst should try to anticipate such future uses and value them so they can be entered as a cost for the project. Note, however, that this does not mean that all idle resources will have some productive use in the future. It is very possible that a shadow price of zero is appropriate. The point is that the analyst needs to consider the possibility that there will be an opportunity cost involved during the project period. In cases of great uncertainty, the analyst may merely wish to test alternative assumptions in a sensitivity analysis (chapter 7).

6
Conducting the Analysis (Comparing Costs and Benefits)

6.1 Introduction

Once inputs and outputs have been identified and quantities designated in the physical flow table and unit values have been estimated for inputs and outputs (or at least for those for which values can be estimated), it is possible to begin conducting the analysis by comparing costs and benefits in various ways to answer the questions asked by decisionmakers. This involves several steps

- constructing value flow tables (section 6.2);
- discounting benefits and costs (section 6.3); and
- computing financial and economic measures of project worth (section 6.4).

6.2 Constructing Value Flow Tables

The first step in the analysis is to combine the information from the physical flow and unit value tables into value flow tables such as described in chapter 3 (see tables 3.6 and 3.12).

If a financial analysis is being conducted, this value flow table will be referred to as a *cash flow* table (see table 3.6), as only financial values and market prices have been considered in the analysis. If an economic efficiency analysis is being conducted, this value table will be referred to as a *value flow* table (see table 3.12), as economic values of costs and benefits have been considered.

6.2.1 The relationship between financial cash flow tables and economic value flow tables

It is instructive to look at the main differences between the total value flow table for the economic analysis and the cash flow table used in the financial analysis (as described in chapter 2). Three types of adjustments need to be made in constructing an economic value flow table from a financial cash flow table. These adjustments involve

1. adding some costs and benefits that are not included in the cash flow table;
2. revaluing some costs and benefits in the cash flow table, using shadow prices instead of market prices; and
3. removing transfer payments from the cash flow table and adjusting for differences in timing of economic and financial costs and economic benefits and financial returns.

The first two of these adjustments have already been discussed (the first in chapter 4 and the second in chapter 5). The third adjustment—the treatment of timing problems and transfer payments which show up in the cash flow table—is discussed below.

6.2.2 Treatment of transfer payments and input timing issues.

The following topics are only of concern when the total value flow table is derived directly from the cash flow table. If the total value flow table is derived from the physical input and output tables and the unit value tables, then financial transactions that involve the transfers of money, such as taxes and subsidies that are important in financial cash flow tables, will not show up.

The main types of transfer payments are taxes, subsidies, loan receipts, and repayment of loans and interest. Total value flow tables should be adjusted so that taxes and loan costs are not treated as costs and subtracted from benefits, and subsidies and loan receipts are not added to benefits or netted out of costs.

In the case of loans, Squire and van der Tak (1975) explain the adjustments needed as follows:

> "... the payment of interest by the project entity on a domestic loan merely transfers purchasing power from the project entity to the lender. The purchasing power of the interest payment does reflect control over resources, but its transfer does not use up real resources and to that extent is not an economic cost. Similarly, the loan itself and its repayment are financial transfers. The investment, however, or other expenditure that the loan finances involves real economic costs. The financial cost of the loan occurs when the loan is repaid, but the economic cost occurs when the loan is spent. The economic analysis does not, in general, need to concern itself with the financing of the investment: that is, with the sources of the funds and how they are repaid."

Similar arguments hold for taxes and subsidies, although one additional point needs clarification to avoid a common confusion. Chapter 5 argued that tariffs (taxes) and subsidies should be considered in deriving measures of local w.t.p., i.e., their effect on local prices should not be removed if they are expected to persist during the period of the project. Why is it now argued that taxes levied on the project and subsidies provided to the project should be removed (or not be considered) in the economic analysis? The answer is that two different considerations are being dealt with. In the case of derivation of values to use for inputs into the project and outputs from the project, the interest is in measures which reflect local w.t.p. for these items in the existing markets. The effect on w.t.p. of transfer payments is relevant, given the definition of economic value used here.

On the other hand, in deriving the appropriate economic efficiency measure of project worth, the concern is with real resource flows and real flows of consumer goods or services coming from the project, valued in terms of the opportunity cost and w.t.p. value measures discussed earlier. A tax on the project output value merely means that some of the control over the benefits due to the project are transferred from the project entity to the public sector (government). The real benefits (the increases in consumer goods and services due to the project) do not change because a financial entity pays a tax. To society, the tax is not a cost associated with the project. To the financial entity it is a cost. Similar considerations hold in the case of subsidies given to the project (i.e., where the government shares the money cost of the project). The real costs (the opportunity costs) of the resources used in the project remain the same with or without a subsidy, and these are the costs which are of interest in the economic efficiency analysis.

To summarize, taxes and subsidies do influence the w.t.p. for goods and services (and the size of the market and the local price which is established), but they do not alter the real costs of a project nor the real benefits produced by the project from the standpoint of society. The two considerations are quite separate.

Depreciation should not be included in the economic analysis (nor should it have been included in the cash flow table). Depreciation is merely an accounting item and represents an internal transfer of some of the money profit from one account to another, in order to provide for replacement of assets. In the economic analysis, it is the real cost of an input that is relevant and its cost is entered at the time it is used in the project.

Finally, it should be pointed out that if the value flow table for the economic analysis is derived directly from the cash flow table, the analyst has to be careful to adjust the timing of entries in the value flow table to take into account the fact that costs in the economic analysis occur at the time resources are actually used in the project, or taken out of alternative uses and benefits occur when outputs are consumed.

In the financial analysis, costs occur when payments are made, and this may be at some time other than when resources (inputs) are actually used in the project. For example, a given input may be used in the project in year 5, but paid for in years 6 through 8 (on an installment basis). In the cash flow table, the cash outflow would occur in years 6 through 8. In the economic analysis, the value of the input should be entered in year 5.

Similarly in the case of outputs or benefits. In the cash flow table for the financial analysis, the cash inflows or returns are entered when they actually occur. A given output may be paid for (to the project financial entity) after (or before) it is actually used (consumed). Thus, the return may appear in the cash flow table in a year that is different from that in which the output actually becomes available. In the economic analysis, the benefit should always be entered in the year in which the output is consumed or used.

6.3 Discounting Benefits and Costs

If all costs and benefits of a project occurred at the same point in time, then the analyst could merely add up costs, add up benefits, and compare them without further adjustment. However, costs and benefits of a project occur over the life of the project. Typically, the life of forestry projects can cover a substantial number of years.

Project costs and benefits which occur at different points in time (in different years) cannot be directly compared. That is because value is intimately associated with time. The value of costs and benefits depends on when these costs and benefits occur. Thus, $1 of benefits occurring ten years from now is not as *valuable* in today's terms as $1 of benefits occurring immediately. If $10 is spent today and $15 is received back tomorrow, that may be acceptable. But if $10 is spent today and the $15 is not received back for 40 years, that may not be acceptable. The amounts are the same. The difference is time and people's willingness to accept delays in consumption.

For most forestry project analyses, costs and benefits occurring in the same year are traditionally considered to have the same relative time value in terms of the present. That is, all costs and benefits occurring within a given year, even though they occur at different times during that year, are considered as having occurred at the same time. Thus, there is no problem in summing costs and benefits for any given year to determine net benefits. The problem is how to compare net benefits (costs) which occur in different years. Since time does have an influence on value, the analyst will want to develop information that permits the decisionmaker to compare the costs and benefits which occur at different times and to compare projects which have different cost and benefit streams over time.

More specifically, the question is: How can a value occurring in some future year (year n) be equated with a value occurring in the present (year 0)? That is, how can the net benefit (cost) items occurring in the bottom line of the value flow table be compared?

The common approach is to apply an *adjustment* factor to future net costs/benefit values that reflect their present value. The adjustment factor is derived from the accepted time value of money; it is commonly called the *discount rate*. The adjustment process is called *discounting*.[22]

6.3.1 Determining the discount rate

In the financial analysis, the going rate of interest is the one to use. That will vary from situation to situation. For example, the rate for smallholder tree growers will tend to be higher than the rate for well-established, low risk companies borrowing from regulated banks. In many cases, e.g., when looking at the financial attractiveness of farmer investments, the rate chosen will be only a rough approximation of the average of the various rates relevant to different individuals. In the case of more established entities operating entirely in the monetary sector, an estimated average bank lending rate may be appropriate. The analyst will have to use judgement in choosing an appropriate rate. There is no formula nor mechanistic means for deriving a rate.

In the economic efficiency analysis consumer's willingness to pay for goods and services is used as the common yardstick for valuing both costs and benefits. Therefore, the discount rate used to discount costs and benefits should be the *consumption rate of interest*. This rate should measure the discount attached to having additional consumption next year rather than this year. The appropriate magnitude of this discount rate (or rate of interest) is determined by a number of factors, including society's preference for present consumption at the expense of more rapid growth (higher savings and investment now with higher consumption in the future).[23]

As it turns out in practice, just as in the case of SER, the forestry project analyst will generally not have to be concerned with the derivation of an appropriate consumption rate of interest (or shadow discount rate) to use in the overall analysis of economic efficiency. The rate used should be one that is in general use in the project country. Thus, the analyst should obtain the

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[22]The discount rate is often called the *interest rate*.

[23]See Squire and van der Tak (1975), p. 27.

appropriate discount rate from a central planning unit (e.g., national planning office) or from the analyst's administrative agency.[24]

At the extreme, if there is no discount rate available from the central planning office at the time the analysis is being undertaken, the analyst can pick a rate such as 8 or 10 percent and use that in the main analysis, and then test the sensitivity of the worth of the project to alternative rates of discount. (As will be discussed later, one widely used measure of economic efficiency, the internal rate of return, does not directly require determination of the appropriate discount rate in order to calculate the measure.)

There is sometimes a tendency to argue for use of *lower* discount rates in social or environmental forestry project analyses. The argument is that there are certain *nonquantifiable benefits* from such projects which justify the use of a discount rate that is lower than the one used to evaluate other projects in the general economy.[25] This is not recommended. Instead, analysts should use the established or acceptable discount rate used for evaluation of other projects and then discuss in qualitative terms the *unique* conditions associated with their project that make it *different* from other projects. This forces analysts and project planners to be explicit about their assumptions, thus avoiding the possible hiding of the efficiency shortcomings of a project behind a lower than normal rate of discount.

6.3.2 Applying discounting formulas

The process of adjusting a future value to the present is called discounting. The resulting *adjusted* value is called present value (PV).

The basic formula for discounting is the following:

$$PV = FV_n \left(\frac{1}{(1+i)^n} \right)$$

where

PV = present value
FV_n = future value in year n
i = discount rate (expressed in decimal form)
n = number of years until future value occurs
$\left(\frac{1}{(1+i)^n}\right)$ is commonly called the *discount multiplier*

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[24]This recommendation provides a convenient excuse for not getting into the problems involved in determining the appropriate rate of discount. Since there is no general agreement among economists or policymakers concerning the appropriate derivation of the discount rate to use for public projects, it would, in any case, be futile to try to resolve the problem in this type of guide. An excellent review of the arguments is provided in Mikesell (1977).

[25]The same argument is often used by planners in the water resources field.

There are tables prepared and widely available which give the value of the discount multiplier ($1/[1+i]^n$) for a wide range of interest rates and years. Further, it can also be calculated with simple pocket calculators, if they have a constant or a y^x key, or a log function. Thus, the analyst will have no problems deriving the value of the discount multiplier for any number of years. For example, using box 6.1, $1/(1.08)^2$ is equal to 0.8573, and this value times \$100 gives the result of \$85.73 arrived at earlier.

Box 6.1. Calculating present value.

Given a discount rate of 8 percent, the present value of a \$100 payment occurring two years from now can be calculated as follows:

$$PV = \$100 \left(\frac{1}{(1.08)^2}\right)$$

$$PV = \$100 \left(\frac{1}{(1.1664)}\right) = \$100\ (.8573) = \$85.73$$

If the 8 percent discount rate represents the consumption rate of interest, then the result, PV = \$85.73, indicates that \$100 of consumption occurring two years from now is equivalent in present value terms to \$85.73 of consumption occurring today. Put another way, it can be said that society is indifferent between (a) consuming today goods and services valued at \$85.73 and (b) waiting two years and being able to consume \$100 worth of goods and services. In other words, \$10.43 more of goods and services would be required two years from now (or a total of \$100 worth) in order to forego \$85.73 of consumption at present.

In this discounting example the value of $\left(\frac{1}{[1.08]^2}\right)$ was calculated directly.

The basic discounting formula and tables are all that is needed to derive useful measures of project worth. However, in some cases other formulas—derived from the above basic formula—can provide useful shortcuts in carrying out calculations. For example, sometimes equal annual or periodic payments are associated with a project for a number of years during its life. In this case, there are formulas and tables which provide the present value of such payments without having to discount each of the annual or periodic amounts separately. Similarly, in some cases the analyst will want to find an annual equivalent of a given value occurring at some time, or to find the present value of an annual series of payments occurring every year. The most common of these formulas are shown in annex 6.1.

6.4 Computing Measures of Financial and Economic Efficiency

Several indexes or indicators of project worth which take the influence of time into account (i.e., involving discounting) are in common use. There is no single measure of a project's worth which is universally accepted, since all share the characteristics of providing only partial information on project performance. Different indicators are needed and used for answering different questions. However, several measures are widely used in financial and economic analyses. These are the net present worth (NPV) and the internal rate of return (IRR). The measures are interrelated since all are derived from the same basic data, namely, the project's costs and benefits, as presented in the value flow tables. The analytical information they provide is, however, somewhat different because of the different ways in which they combine cost and benefit data. These measures are *value neutral*, and can be calculated for both financial and economic analyses.

6.4.1 Net present value

A Philippine tree-farming project and its value flow (table 6.1) will be used as an example to illustrate net present value. Using the basic discounting process described previously, a measure of the present value (PV) of all net benefits (costs) occurring in the various years of the project can be developed once an appropriate discount rate has been chosen. If a discount rate of 5 percent is used, the present value of each of the net future benefit (cost) entries is as shown in row 2 of table 6.1. Adding these items together (taking into consideration whether they are positive or negative) the NPV for the project is P29,310.

What does this NPV of P29,310 indicate? It indicates that, given the assumptions concerning the opportunity costs of the resources used in the project and the w.t.p. for the project output, this project will return a net surplus of P29,310 of consumption benefits in present value terms taking into account the assumed consumption rate of interest (discount rate) of 5 percent, or the relative weight which society places on present consumption versus investment and future consumption. By using the discount rate it has ensured that the NPV result is comparable with those obtained for other projects that would involve different cost and benefit streams over time, i.e., the effect of different time values associated with consumption gained or foregone at different times in the future have been eliminated.

In general, given the above, it can be said that in economic efficiency terms any project that provides a positive NPV is an efficient use of the resources involved, assuming that each separable component also has a NPV ≥ 0 and the project is the least cost means of achieving the particular benefits. (See chapter 3 for review of the three conditions for economic efficiency.)

While a project meeting these conditions is economically efficient, it still may not be chosen for implementation. That depends on the total budget available and the NPV associated with other projects on which the budget could be spent.

A project for which the estimated NPV is negative is not economically acceptable. The negative NPV indicates that there are better uses for the resources involved in the project, i.e., given their opportunity costs and timing and the discount rate, they could be used elsewhere to produce more consumption benefits in present value terms.

Table 6.1. Net present value—Philippine project (5 percent discount rate; value in constant pesos).

	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Net benefits (cost)	(1163)	(1163)	(1163)	(1163)	(100)	(100)	(100)	5286	5887	5887	6523	6523	7147	7147	7759	5887
2. Present value of net benefits (costs)[a]	(1163)	(1107)	(1055)	(1005)	(82)	(78)	(75)	3757	3784	3795	4004	3814	3980	3790	3919	2832
3. NPV at 5%	29,310[b]															

[a] Item in row 1 divided by $(1.05)^n$ for years 1 to 15.
[b] The sum of items in row 2.

Table 6.2. Economic rate of return (ERR)—Philippine project.

	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Net benefits (costs)	(1163)	(1163)	(1163)	(1163)	(100)	(100)	(100)	5286	5887	5887	6523	6523	7147	7147	7759	5887
2. Present value of benefits (costs) discounted at 32%	(1163)	(881)	(667)	(506)	(33)	(25)	(19)	757	639	484	406	309	255	193	159	92
3. NPV at 32%[a]	0															

[a] i.e., sum of the present values of net benefits (costs) discounted at 32 percent per year.

6.4.2 The internal rate of return

In the previous example of NPV calculation, the NPV was P29,310 when a 5 percent discount rate was used. The question could be asked: What rate of discount would have to be used to obtain a NPV of zero, i.e., what is the implied discount rate that would make the PV of project benefits equal the PV of project costs? That rate is called the *internal rate of return*, or the IRR. It is essentially a *breakeven* discount rate in the sense that the PV of benefits equals the PV of costs.

The IRR concept is used both in financial and economic efficiency analysis to produce either an internal financial rate of return (FRR), or an economic rate of return (ERR). The IRR is a commonly used measure in *financial* analysis. It is comparable to the ERR in terms of derivation, although it means something slightly different. The FRR shows the investor what the average earning power is associated with a given investment of his funds. More specifically, *it is the average rate of return on the invested funds outstanding per period while they are invested in the project, or that rate of interest which makes the NPV (using market prices) equal to zero.*

Thus, a FRR of 10 percent indicates to the investor that s/he will receive $0.10 back per year for each $1 invested during the years in which the investment is left in the project. This is a useful measure for an investor, since it provides a clear means for comparing alternative uses of funds. Say that the investor's best use of funds, other than putting them in the project, is to put them in the bank at 6 percent interest per year. The investor compares the rate of return on the project (10 percent) with the rate of return from the bank (6 percent), which is called the *alternative rate of return* (ARR), or the investor's opportunity cost of capital,[26] and s/he then knows that the project use will give a greater return than the best alternative use.[27]

The ERR is similarly interpreted, except it shows the decisionmaker what society can expect to receive back in consumption benefits for a given investment of its scarce resources. In other words, if the calculated ERR is 10 percent, this tells the decisionmaker that the average annual return of consumption benefits on resources outstanding per period while they are invested in the project will be $10 for every $100 of resources invested and left in the project. The ERR will be compared with the consumption rate of interest to see if the project earns enough to make it worthwhile to invest (forego consumption now in favor of future consumption). Say that the relevant consumption rate of interest is 5 percent. This means that society wants to get at least a 5 percent rate of return on investment of its resources to make it worthwhile to forego present consumption in favor of investment and future consumption. If the ERR turns out to be 10 percent for a given project, this means that, on the average, society will get more than the minimum acceptable 5 percent back. Thus, the project is economically efficient in terms of its use of scarce inputs assuming that the other two conditions for economic efficiency are met.

The Philippine example is used to show how the ERR is calculated. The undiscounted net benefit (cost) items for each year are shown in row 1 of table 6.2. By discounting these by 32 percent the PV figures as shown in row 2 are obtained. If these values are totalled, the NPV is zero

[26]This concept of *opportunity cost* is analogous to the one used throughout the *Guidelines*.

[27]The FRR and the ARR should be calculated net of inflation, i.e., in real terms.

which by the definition occurs when the economic rate of return is used to discount all net benefits (costs). Thus, 32 percent is the ERR.

The calculation to find the ERR or the interest rate which makes NPV equal to zero has to be by trial and error.[28] Annex 6.2 provides details on how to calculate the ERR.

What does the ERR of 32 percent indicate in the Philippine example? It represents the *yield* of the resources used in the project over the project period. It means that $1 invested in the project will generate $0.32 per year for every year that the $1 remains committed to the project. It also indicates that this return is greater than the assumed consumption rate of interest of 5 percent, which measures the trade-off between consumption in a given year t_0 and consumption delayed until the following year, t_1.[29] Society should be interested in leaving its resources in a project such as this rather than consuming them now because it will receive more back in the future than is needed to satisfy its perceived trade-off between present and future consumption.

Just because a project has an ERR that exceeds its consumption rate of interest, this does not automatically mean that the project will be accepted and implemented. It does mean that the project represents an efficient use of resources, given acceptance of the consumption rate of interest as being the relevant one.[30] However, there is always the possibility that other uses of a limited budget can provide higher rates or return than the project being studied.

The above two measures can be used to answer the economic efficiency question as it relates to both project components and entire projects. When NPV is used, the usual approach—as discussed in chapters 2 and 3—is to analyze components first, making sure that all separable components ending up as part of a project *package* have NPVs at least equal to zero. Once a set of economically efficient project components has been assembled into a project, then exactly the same approach can be used in calculating the NPV or ERR for the total project. As mentioned, the least cost condition for economic efficiency does not involve calculation of a NPV or an ERR. Rather, the costs of alternatives are compared directly to find the least cost alternative.

Some analysts prefer to treat the costs avoided by undertaking the project instead of the least cost known alternative as the *benefits* of the project alternative being analyzed. These benefits are then used in calculating a NPV for the project alternative being analyzed. If it is positive, then this shows that it is the least cost alternative among the known set of alternatives. If the NPV is zero, then the least cost alternative to the project has costs exactly the same as the project being analyzed. If the NPV is negative, then the alternative to the project being analyzed has lower costs. While there is nothing conceptually wrong with this approach, it can become confusing; thus, it is recommended that costs of alternatives are compared directly. (Confusion can arise in cases where the project has to be compared with other entirely different projects which are competing for the same budget. In point of fact, the costs avoided by undertaking one alternative

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[28]Some low cost pocket calculators will calculate the ERR directly.

[29]If NPV $>$ 0, then ERR $>$ i used; if NPV = 0, then ERR = i used; if NPV $<$ 0, then ERR $<$ i used. Where "i" equals the discount rate used.

[30]Assuming that the other two conditions for economic efficiency are met.

rather than another to achieve a given output do not necessarily represent a true measure of benefits.)

6.4.3 Relationships between NPV and ERR

NPV and the ERR represent alternative means of presenting the relationship between costs and benefits. In mathematical terms the relationship between the two is as follows:

$$\text{Net present value} = \sum_{t=0}^{n} \left[\frac{(B_t - C_t)}{(1 + i)^t} \right]$$

Economic rate or return is that discount rate ERR such that

$$\sum_{t=0}^{n} \left[\frac{(B_t - C_t)}{(1 + ERR)^t} \right] = 0$$

where

B_t = benefits in each year t
C_t = costs in each year t
n = number of years to end of project
i = discount rate or consumption rate of interest (CRI)
ERR = the internal economic rate of return

From these definitions, the following relationship holds: When NPV = zero, then the ERR = i, or the consumption rate of interest (or the discount rate used in calculating the NPV). Given the definitions and the above relationship between the two measures, what can be said about the information provided by each of them in terms of the three conditions for economic efficiency mentioned in chapter 2.[31]

Neither of the two measures of project worth tell anything about the least cost (or third) condition for economic efficiency. This condition has to be studied in a separate analysis undertaken in the design and preparation stages of the project.

Both measures do provide information related to whether PV of benefits are less than, equal to, or greater than the PV of costs for a project component and the total project. In point of fact, they both provide exactly the same answer to the question of whether or not a project or project component is economically efficient in terms of these first two conditions. If a project is accepted as being efficient in terms of one measure (i.e., NPV $\geq$ 0), it will also be acceptable in terms of the other measure (i.e., ERR $\geq$ CRI) and vice versa.

[31] These are: (1) total present value of project benefits must be equal to or greater than total present value of project costs; (2) each separable project component must have PV of benefits at least equal to PV of costs; and (3) there is no lower cost means of achieving the project benefits.

So far in the discussion, it can be seen that either of the two measures could be used equally well to determine whether a project is economically efficient (assuming no lower cost means to achieve the project objectives is known to exist). Thus, the choice of which of the two to calculate and use is unimportant in terms of this basic question, although the analyst obviously has to calculate the measure commonly used by the institution for which s/he is carrying out the analysis.

Each of the two measures provides additional information that the other does not provide. The NPV measure, in contrast to the ERR, provides information on the absolute value or magnitude of the present value of net benefits of a project. Yet it tells nothing about how large the cost will be to achieve the NPV. Thus, there could be a project with a NPV of $1,000 which costs $2 million or one with the same NPV that costs $5,000. Both would have the same NPV. On the other hand, the ERR is a relative measure of project worth, which gives information on the returns per unit of cost and thus provides more relevant information for comparing the benefits which can be expected from alternative uses of a limited budget. Therefore, it is more useful for ranking independent project alternatives when it is not possible for budget or other reasons to undertake all projects that meet the basic economic efficiency conditions.

Table 6.3 summarizes the differences between ERR and NPV measures.

Table 6.3. Summary of the measures of investment worth.*

Measure	Discount rate	Decision criterion**	Mutually exclusive alternatives**	Independent projects**	Comments
NPV	ARR***	Accept alternatives where NPV $\geq$ 0	Accept alternative with highest NPV	Accept alternatives where NPV $\geq$ 0	Cannot directly compare alternatives with unequal lives
ERR	Determined internally	Accept alternatives where ERR $\geq$ ARR	Usually not appropriate	Accept alternatives where ERR $\geq$ ARR	May give incorrect ranking among independent projects; more difficult to calculate than other measures

* There is some disagreement about the relative merits and applications of the criteria. The recommendations presented here represent the authors' viewpoints.
** Any measure of investment worth only provides one source of input into the final decisionmaking process. Other factors that should be evaluated include a sensitivity analysis, personal preferences, and distribution of costs and benefits throughout the life of the investment.
*** Alternative rate of return.

Annex 6.1

Common Discounting and Compounding Formulas

As mentioned in the text, using the value flow table as a basis for NPV and ERR calculations, the analyst avoids the need for discounting and compounding formulas other than the simple present value formula. However, there are occasions where the analyst may find it convenient to use other formulas, all derived from the basic one, which permits s/he to calculate in one step the present values for equal annual or periodic series of payments or to obtain an annual equivalent for a present or future value (e.g., where s/he wants to calculate a rental equivalent for a purchase price).

1. Calculating the present value of a periodic series of equal payments

Table A6.1 summarizes the main formulas needed to calculate the present and future values of annual and periodic payments (costs or benefits). The PV derived by using these formulas is expressed in terms of one year (period) prior to the year (period) when the first payment occurs. Thus, the analyst has to make sure that s/he appropriately compounds or discounts the result if s/he wants PV expressed in terms of a different year (period). Application of the formulas is illustrated below.

PV of equal annual payments

Assume a situation where there is an annual maintenance fee of $12 for a plantation which starts at the beginning of year 2 (the third year) of the project and continues up to and includes year 15. Thus, there are (15-2) + 1, or 14 equal payments of $12. How would the PV of this series of payments be calculated, if the discount rate is 8 percent?

First, applying the appropriate formula from table A6.1 (formula 1 for a finite number of payments) the following result is obtained:

$$\$12 \left(\frac{(1.08)^{14}-1}{.08(1.08)^{14}} \right) = \$12\ (8.24) = \$99$$

This gives the PV in year 1 of the 14 payments starting in year 2.

Second, discounting this value ($99) back one more year ($99/[1.08]) the PV in year zero is $91.60.

This formula might be useful if, for example, the analyst wanted to compare the present value of two alternative equal annual cost streams. Assume that two alternative plantation management schemes were possible, one involving four equal costs of $30/ha for years 1 to 4 and another involving ten equal costs of $10/ha for years 2 to 11. The PV in year zero for the first alternative would be (using 8 percent):

$$\$30 \frac{(1.08)^4 - 1}{.08(1.08)^4} = \$99.36$$

(This is already in year zero terms since payments start in year 1.) For the second alternative, the PV in year zero would be:

$$\$10 \frac{(1.08)^{10} - 1}{.08(1.08)^{10}} = \$67.1 = \text{PV year 1}$$

$$\frac{\$67.1}{(1.08)} = \$62.13 = \text{PV year zero}$$

Thus, the analyst can see that in PV terms the second alternative provides the lowest cost, assuming that the relevant discount rate is 8 percent.

Present value of a series of equal periodic payments

If payments (costs or benefits) occur every t years instead of every year for a specified period of time, then formulas 5 and 6 in table A6.1 to obtain PVs can be used. For example, suppose there is a situation where fertilizer will be applied to a stand every five years, starting five years from now and lasting during the entire rotation of fifty years except for year fifty. This means that there would be nine equal applications starting in year five and ending in year 45. Assume that the cost each time is estimated to be $20/ha. How would the PV of these payments to estimated? Looking at table A6.1, formula 5 would be used for a finite number of periodic payments. The PV would be calculated as follows, assuming a discount rate of 8 percent, $t = 5$, and $N = 9$:

$$\$20 \frac{(1.08)^{45} - 1}{(1.08)^{45}\left[(1.08)^5 - 1\right]} = \$41.28$$

If there were also an application of fertilizer at the time of establishment, that amount would have to be added to the PV obtained above. The most common use in forestry of formulas for calculating the PV of series of equal periodic payments is in calculation of the SEV. This is explained and illustrated below.

Soil expectation value. The SEV gives an estimate of the present value of land if it were put into forestry and produced an infinite number of net returns of $R every r years (where r is the rotation length).

To estimate the SEV, the net benefit of forestry production at the end of the first rotation R is calculated, without taking actual land cost into account and then the NPV of a future periodic series of net benefits of $R is computed beginning with $R received at the end of the first rotation. Thus, for example, assume a situation for a plantation as follows:

Establishment cost	$250
Rotation	11 years
Annual cost	$10 starting one year from now
Stumpage value at rotation	$1,000
Discount rate	8 percent

The compounded value of the establishment cost at the end of the first rotation (year 11) is:

$$\$250\,(1+0.08)^{11} = \$583$$

The compounded value in year ten of the ten equal annual costs ($10 each year between years 1 and 10, both inclusive) can be calculated by using formula 2, table A6.1:

$$\$10\left(\frac{(1+0.08)^{10}-1}{0.08}\right) = \$145$$

which must be compounded for one additional year:

$$\$145\,(1+0.08) = \$157$$

Therefore, total costs at the end of the first rotation (year 11) are $583 + 157 = $740 and net benefits at rotation age are $1,000 - $740 = $260.

The present value of an infinite series of payments of $260 received every 11 years, or the SEV of this forestry management alternative, can be calculated by using formula 5 in table A6.1, for an infinite number of periods:

$$SEV = 260\,\frac{1}{(1+0.08)^{11}-1} = \$195$$

What does this SEV of $195 mean? It has several meanings. Most commonly in forestry it is used to determine what amount could be paid for the land to breakeven, i.e., have PV of costs equal PV of benefits, using a discount rate i (in this case 8 percent). More generally it indicates the PV of the productive capacity of the land, given the values assumed and the assumption that the land could continue to produce timber in perpetuity at the given rate.

2. Annual equivalency formulas

Formulas 3 and 4 in table A6.1 are used to calculate annual equivalents of given amounts of PV of costs or benefits. The formulas are merely the inverse of formulas 1 and 2. Assume, for example, that two alternative incentive programs for tree farmers are being compared. One alternative is to given them a lump sum today of $100. The other alternative considered is to provide them with five equal payments over five years, starting one year from now. For the latter incentive to be effective, the annual amount should equal the $100 of PV using their relevant discount rate. In this case it is assumed to be high—30 percent—since they value present income considerably higher than future income. To find the annual payments necessary, formula

3 for a finite number of payments is applied. The annual amount that would have to be paid, starting one year from now, to make the farmers indifferent between $100 now and the five equal payments, would thus be:

$$\$100 \; \frac{.30 \; (1.30)^5}{(1.30)^5 \; -1} \; = \; \$41$$

In other words, given their relevant discount rates (or their trade-off rates between present and future income) they would have to be paid $41 per year for five years to make them indifferent between the two payment forms.

Table A6.1. Annual and periodic payment formulas.

	(1)	(2)
	Payments begin one year (or period) from present	
	Finite number of payments	Infinite number of payments
1. Discounted annual payment factor	$\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$	$\left[\frac{1}{i}\right]$
2. Compounded annual payment factor	$\left[\frac{(1+i)^n - 1}{i}\right]$	n.a.
3. Annual capital recovery factor	$\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$	n.a.
4. Annual sinking fund factor	$\left[\frac{i}{(1+i)^n - 1}\right]$	n.a.
5. Discounted periodic payment factor	$\left[\frac{(1+i)^{nt} - 1}{(1+i)^{nt}\left[(1+i)^t - 1\right]}\right]$	$\left[\frac{1}{(1+i)^t - 1}\right]$
6. Compounded periodic payment factor	$\left[\frac{(1+i)^{nt} - 1}{(1+i)^t - 1}\right]$	n.a.

i = rate of interest (discount) in decimal form

n = number of years or periods until last payment starting with 1 year from now

t = number of years between periodic payments

Annex 6.2

How To Calculate the Economic Rate of Return (ERR)

Although several relatively inexpensive hand calculators contain programs (or can be programmed) for rate of return calculations, the analyst might be faced with situations in which the computation of ERR would have to be based on more rudimentary methods. There is no formula for calculating the ERR when more than one cost and/or benefit is involved. Therefore, a trial and error technique has to be used. The approach is as follows:

1. First, calculate a NPV using a rate which is estimated to be in the neighborhood of the expected ERR. If the NPV is negative, then the ERR must be lower than the rate of discount used. If the NPV is positive, then the ERR must be higher than the discount rate adopted.

2. If the first NPV calculated is negative, then reduce the discount rate up to a point where the calculated NPV is positive and vice versa if the first NPV calculated is positive. The ERR must now lie between the two rates of discount used in generating the positive and negative values of NPV.

3. Estimate the ERR by using the following formula:

$$ERR = (\text{low rate of discount}) + (\text{difference between both rates of discount}) \times \left(\frac{\text{Positive NPV}}{\text{absolute difference between positive and negative NPVs}}\right)$$

4. Repeat steps (1) - (3) for a more precise result, if needed.

The following example, which uses the figures of the Philippine tree farm project, illustrates the use of this technique:

Table B6.1 shows in row 1 the net benefits (costs) of the Philippine tree farm project (from table 6.1). The second row contains the PV of each annual flow discounted at 20 percent. The NPV, using this discount rate is positive and equal to P 4,638 and, therefore, the ERR must be higher than 20 percent. A further discounting attempt at 30 percent generated a still positive NPV equal to P 453. Therefore, a still higher discount rate of 35 percent was tried, which rendered a negative NPV of -P 543. The ERR must then lie between 30 and 35 percent. Using the formula from step (3) above, the ERR of this project is estimated as follows:

$$ERR = 30\% + 5\% \frac{453}{996} = 32.27\%$$

This is rounded off to 32 percent.

A further interpolation using a narrower range of 31 and 33 percent would have produced NPVs equal to P 215.6 and -P 198.5, respectively. Using these two new values, a second estimate of ERR would be 32.04 percent. But since the result is being rounded off to the nearest whole percentage point, this additional refinement is unnecessary.

Table B6.1. Calculating the ERR - Philippine project.

	Years															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Net benefits (costs)[a]	(1163)	(1163)	(1163)	(1163)	(100)	(100)	(100)	5286	5887	5887	6523	6523	7147	7147	7759	5887
2. Present value of net benefits (costs) discounted at 20%/yr	(1163)	(969)	(808)	(673)	(48)	(40)	(34)	1475	1369	1141	1054	878	802	668	604	382
3. Present value of net benefits (costs) discounted at 30%/yr	(1163)	(895)	(688)	(529)	(35)	(27)	(21)	842	722	555	473	364	307	236	197	115
4. Present value of net benefits (costs) discounted at 35%/yr	(1163)	(861)	(638)	(472)	(30)	(22)	(16)	647	534	395	324	240	195	144	116	64

[a] From table 6.1.

7
Dealing With Uncertainty: Sensitivity Analysis

7.1 Introduction

Mention has been made that: (1) identification and valuation of costs and benefits for any project involve looking into the future; (2) estimates of present and future values are subject to uncertainty; and (3) the analyst needs to recognize and to treat explicitly the uncertainty surrounding forecasts of future events and values. This chapter considers how to treat uncertainty in a project analysis. The main technique suggested is sensitivity analysis, or the testing of the sensitivity of the chosen measure(s) of project worth to alternative assumptions about values of inputs and outputs and various technical relationships, i.e., how the value of the NPV or ERR changes if the assumed value(s) of a given parameter (group of parameters) is (are) changed.

Uncertainty refers to the fact that the analyst cannot be sure today about anything that is going to happen in the future. Or, because of inadequate information, the analyst cannot be sure about past and present events which provide a basis for forecasting future conditions. Using available information relating to past events the analyst makes estimates (or guesses) of what is likely to happen—what the future demand for pine sawnwood will be, what the cost of labor will be, how natural hazards will affect a plantation project, etc. However, the analyst is never certain how close these estimates will be to what actually will happen. There always is some uncertainty involved.

The analyst may feel more confident about some estimates than others, particularly if there is more experience (more accurate observation of past events and trends) on which to base the estimates. In some cases the analyst may even have enough quantitative information about past occurrences to be able to estimate the statistical probability of the occurrence of some future event. This is referred to as a situation of *risk*. In contrast, when there is little or no basis for deriving quantifiable probabilities, there is a situation of *uncertainty*.

While this distinction between risk and uncertainty is useful in conceptual discussions, it may merely serve to confuse the analyst dealing with a real project, since in reality the analyst is dealing with a continuum from one extreme, where probabilities of occurrence can be quantified (e.g., in cases where actuarial evidence is available), to the other extreme where no information is available on which to base probability estimates. In most cases, the forecasting problems faced in project planning fall somewhere between situations of risk and total uncertainty.

7.2 Purpose of Treating Uncertainty

In the assessment process, the analyst identifies and then values the inputs and outputs associated with the project being analyzed (chapters 4 and 5). The resulting *expected* values, i.e., those considered to be most likely to occur, are then used in the initial calculation of the chosen measure(s) of project worth (chapter 6). To make a complete and useful economic analysis the analyst also has to provide some idea of what would happen to the chosen measures of project worth or efficiency if the actual values of various inputs and/or outputs turn out to be different from the expected values used in the analysis. If a *reasonable* change in the assumption about the expected value for a given parameter (or value of a combination of parameters) is *critical* in terms of the expected measure of project worth or efficiency, the analyst generally will want to take some steps to reduce the uncertainty. The term *reasonable* in this context refers to an estimate of what the possible values are for a parameter around the expected value used in the basic analysis. The term *critical* generally refers to the point where the measure of project worth or efficiency moves from positive to negative (or vice versa) in terms of the relevant decision criterion.[32]

Box 7.1. Sensitivity to changing values over time.

As an example, assume a 20-year plantation project where labor is a major cost component. The expected value of labor used in calculating the NPW of P1,200 for the project is P2 per day. This value (shadow price) for labor is based on a reduction of 50 percent in the current actual wage to account for high unemployment in the project area. The P2 per day figure is used for the entire project period. However, looking at developments in the project region over the past ten years, and considering planned developments in the region, it is felt that, even if the project being analyzed were not undertaken, unemployment may be reduced gradually over the project life. Thus, it is reasonable to test the sensitivity of the project NPW to an assumption that labor value will gradually increase to P4 (the actual wage level) by year 10 and then continue at that level until the end of the project (10 more years). Note that no quantitative basis exists on which to estimate how the wage rate will change in the future, with or without the project. The different wage rate assumption used in the sensitivity analysis is considered reasonable on an intuitive basis. Most such judgements have to be made on an intuitive basis. The analyst may want to test several other wage rate assumptions in addition to the P4 per day, for example, an increase beyond P4 per day for the last ten years of the project. That will depend on his judgement, the time and funds available for the analysis, and the results of the sensitivity analysis using the initial reasonable assumption concerning possible changes in labor value (from P2 to P4/day). If the project outcome is not sensitive to this assumption, then it will not be sensitive to a change in the expected labor value that is less extreme than P4 per day. Thus, there will be no need to test other, less extreme values. However, more extreme values can be tested.

7.3 Guidelines for Treatment of Uncertainty

The following practical systematic approach to analyzing uncertainty is recommended. It involves three steps which are explained in more detail later:

1. identify likely major sources of uncertainty for the project being analyzed, and for each source establish some estimate of a reasonable range of values for the parameters involved;

2. carry out a sensitivity analysis for the project using various combinations of different assumptions concerning the values of the parameters associated with the major sources

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[32]For example, when the NPW moves from positive to negative, using the guiding discount rate to discount costs and benefits, or when the ERR falls below the discount rate used for evaluating public projects.

of uncertainty and analyze in more detail the parameters for which changes in value assumptions are critical in terms of project outcome; and

3. determine appropriate ways of changing the design of the project or modify it to eliminate or reduce the major sources of uncertainty which are critical in terms of project outcome.

Sensitivity analysis provides a low cost means to identify critical project parameters in order to design a sound, workable project, and to understand and reduce the uncertainty surrounding the project outcome. The degree to which further information is generated on critical parameters to which the project outcome is sensitive depends on the funding available, the estimated impact of uncertainty on project outcome, and other factors. The three steps outlined above provide a logical framework for the process.

7.4 Identifying Likely Major Sources of Uncertainty

Uncertainty is associated with the availability and timing of most inputs and outputs, relationships between inputs and outputs (production functions), input and output prices (or values), and even the objectives of the project. It would be difficult and expensive to deal with all the uncertainties associated with every factor involved in a project. Thus, a first step is to identify systematically the major categories of uncertainty associated with a proposed project, and initially assess their potential importance to project decision making.

In forestry projects some of the main sources of uncertainty which may be important include:

1. *Natural factors* such as weather, incidence of fire, insects and diseases, and natural variation between and within species grown in different locations. These elements of uncertainty are often particularly important for plantation projects since the period between investment and return (harvest) can be long. (In some cases these factors can be analyzed in terms of probabilities.)

2. *Technology and productivity factors* related to processing different types of wood, input-output relationships in tree growing, processing yields, effects of alternative technologies (including silvicultural systems) on nonwood values derived from forests, labor productivity, transportation systems, etc.

3. *Financial and economic factors* related to values assumed for inputs and outputs, availability and cost of capital, etc.

4. *Human factors* related to labor availability and cost, the ability to forecast future events (wood volume availability, markets, etc.), and, most important, management capability.

The potential importance of any of these sources of uncertainty will depend on the circumstances surrounding the particular project being analyzed. Theoretically, the analyst could test the sensitivity of project outcome to changes in assumptions concerning any input or output parameter or combination of such. In practice, the sensitivity analysis will be limited to a few major potential sources of uncertainty for any given project. The analyst has to use good judgement in deciding which parameter values to test in the sensitivity analysis, given time and budget constraints. If future labor values are particularly uncertain for example, and labor is an important input item in the project, then a sensitivity analysis should be carried out for alternative assumptions concerning future labor value (see previous example). Generally, the analyst should analyze the impact on project worth, or other chosen measures of economic efficiency, of changes in estimated output values, since these often have the greatest impact on project outcome. There are no rules for choosing the parameters or combinations to be tested. The FAO case studies provide examples of which items were chosen to be tested in a variety of actual forestry project situations.

In general, if an acceptable NPV and/or ERR is obtained for a project, using the initial estimates of parameter values (the *expected* values), then the analyst will be interested in testing alternative value assumptions that are less favorable in terms of project outcome, i.e., higher cost assumptions and/or lower benefit assumptions. The results provide some indication of how large unexpected cost increases or benefit value reductions would have to be to have a critical effect on the chosen measure(s) of project worth (see previous definition of critical).

To summarize, the analyst first assesses what the main elements of uncertainty and risk are likely to be for the proposed project. This type of assessment may identify some potential problems, i.e., delay in start-up, potential factor cost increases, wood supply bottlenecks, market uncertainties, etc. Such information provides the analyst with a first approximation of the factors which should be tested in the sensitivity analysis. The analyst then looks at the relative magnitude and timing of various input and output items (which can be identified from the value flow tables for the project being analyzed) and lists all those which represent a significant part of project benefits or costs. The analyst then makes an initial estimate of a range of values which could reasonably be expected for each, relying on past experience and projected trends. At this stage, the analyst should err on the side of making the range too broad, rather than too narrow—narrowing can occur in later stages of the analysis. The analyst also makes some estimate of the interdependence of the values of the input and output factors, e.g., the extent to which lower or higher prices for some inputs and outputs are associated with lower or higher prices for other inputs and outputs.

In practice, the analyst generally ends up with a limited number of major parameters which will be tested in the sensitivity analysis. As mentioned, the case studies cited in Appendix A provide some examples of practical sensitivity analyses for some actual forestry projects.

7.5 The Sensitivity Analysis

Using the list of parameters and estimates of the reasonable range of values for them (as developed in the previous step), the analyst then carries out the sensitivity analysis. However, if systematically organized, it is comparatively simple to carry out the analysis using a hand calculator. There are programmable hand calculators which can easily handle the complex calculations involved in a sensitivity analysis. If time permits, it is better to include a number of sensitivity analyses rather than a few, since sometimes it is not easy to anticipate the factors to which the project outcome is sensitive.

In addition to an analysis of alternative parameter values, the analyst may also want to test the sensitivity of results to delays in implementation, and to changes in assumptions which reflect different objectives. This latter type of sensitivity analysis is relevant in cases where objectives include redistribution of income, environmental quality, increased employment, etc., in addition to the economic efficiency objective.

7.5.1 Using net present value measures for sensitivity analysis

It is usually desirable to test the sensitivity of project outcome to a combination of changes in input and/or output value assumptions and different levels of changes in the values for given inputs or outputs. The sensitivity analysis can be carried out using either NPV or ERR, though NPV is most commonly used.

Table 7.1 shows the sensitivity analysis results for a fuelwood project in the Republic of Korea.[33] Using a 12 percent discount rate, the project had a NPV of 102,500 Won/ha. The table shows the sensitivity of NPV to a 20 percent change in any of the major cost and benefit elements shown in column 1.

Table 7.1. Korea fuelwood case study—sensitivity analysis ('000 Won/ha).

A 20 percent change in:	Causes changes as follows in the NPV:*
	(12.00 percent discount rate)
1. Seedlings	14.20
2. Planting	8.40
3. Fertilizing	2.10
4. Supervision	4.07
5. Miscellaneous - Tools	1.50
6. Harvesting	32.65
7. Fuelwood	79.58

Source: See Case Study no. 2. FAO (1979).
* Net present worth (NPV at 12 percent ≐ 102.55).

The entries in the body of the table are interpreted as follows (using planting cost as an example):

- if planting cost were 20 percent higher than expected, then the NPV (column 2) would be Won 8,400/ha lower, other assumptions remaining as before;
- if planting cost were 20 percent lower than expected, then NPV would be Won 8,400/ha higher.

In other words, the table can be used to estimate changes in NPV due to increases or decreases in the value of any given item.

[33]See Case Study no. 2. FAO (1979).

In addition to these basic interpretations, estimates of sensitivity of measures of project worth can also be derived from

- *Different magnitudes of changes for a given parameter value*. For example, a 40 percent increase in planting cost would result in a W 16,800 (W 8,400 x 2) decrease in NPV. Similarly, a 30 percent increase would result in a W 12,600 (8,400 x 1.5) decrease in NPV.

- *Combinations of changes in input/output values*. For example, suppose all costs shown in the table, except harvesting cost, were assumed to be 20 percent higher. The cumulative effect on NPV would be to reduce it by W 30,270/ha, or ([14.20 + 8.40 + 2.10 + 4.07 + 1.50] x 1,000). Since the expected value of the NPV was Won 102,500/ha, the project would still be considered economically efficient since the NPV would still be positive (Won 102,500 - Won 30,270). Any other combination of changes and magnitudes of changes could be tested in the same way. Thus, it is an extremely flexible and inexpensive approach to testing the outcome of the project (NPV) to a great variety of value assumptions.

It should be noted that the table does not tell the analyst anything about the interaction between factors, i.e., which combinations and magnitudes are most likely. That still remains as a judgmental task of the analyst. But once the analyst has settled on likely combinations, s/he can assess their impacts by using the sensitivity table. Further, the effects of changes in a parameter value are assumed to be linearly related to the measure(s) of project worth (i.e., the NPV in this case).

It is recognized that in some cases an ERR is used instead of NPV as the measure of economic efficiency. A sensitivity analysis using the ERR measure involves recalculation of the ERR for each change in assumption or combination of assumptions.

The sensitivity analysis using NPV as a basis can also provide some critical information concerning sensitivity of ERR to changes in input or output parameter values. This follows from the definitions discussed in chapter 6, where it was pointed out that when NPV is zero the ERR is equal to the discount rate used in calculating the NPV. Thus, in the NPV sensitivity analysis, when costs are increased (benefits decreased) to the point where NPV is zero, then the ERR is equal to the discount rate used. This breakeven point is of interest to decisionmakers (see section 7.5.2).

If the analyst wants to test the sensitivity of ERR to specified changes in parameter values (other than those which result in a NPV of zero), the ERR must be recalculated for each change in value. If a computer is available, it is a simple matter to run through a great number of different combinations in a short time. If a desk calculator is used, it is equally simple in terms of process, but more cumbersome in terms of the time and steps involved. (It should be pointed out that there are some relatively inexpensive calculators available which can handle this type of sensitivity analysis in a short time and in a relatively simple manner.)

7.5.2 Breakeven analysis

One common type of sensitivity analysis is the breakeven (BE) analysis. Decisionmakers are interested in how much parameter values can change before an acceptable measure of project worth becomes unacceptable, whatever the criterion (or criteria) for acceptability. For example, they may want to know how much higher can costs be and/or how much lower benefits can be before the NPV drops below zero, or the ERR drops below the accepted discount rate. Similarly, for projects producing negative NPVs or ERRs below the guiding rate, decisionmakers may want to know how much costs would have to decrease, or benefits increase, in order to make the project acceptable in terms of the chosen criteria. This type of BE analysis provides useful information particularly in cases where the decision on a project will be based on a number of considerations in addition to economic efficiency.

Strictly speaking, BE analysis is usually carried out by varying the value of only one parameter, with all others held constant at their expected values. However, it also can be carried out for a general change in costs or benefits, e.g., by determining what percentage change in all costs is needed to reach the breakeven point, where NPV = zero, or ERR = the accepted discount rate.

The values of parameters being tested which make the NPV = 0 or the ERR = accepted discount rate are called *switching* values, i.e, the values which switch the decision on a project (based on these criteria) from a "yes" to a "no," or vice versa.

In cases where uncertainty about future values or benefits is particularly high, the analyst can use a *cost-price* approach. In this case, the analyst calculates the price or value of the output which would make benefits equal to costs when both are discounted at the accepted discount rate. Thus, this is merely a variation on the basic BE analysis. The following example of calculation of cost price illustrates the approach.

The cost-price approach has further application in cases where a project involves nonmarket priced goods and services, e.g., environmental effects. It provides the decisionmaker with information on what such goods or services have to be *worth* if the project is going to breakeven in terms of the relevant social rate of discount. While the decisionmaker may not be able to decide on a specific value for some nonmarket priced output, it may be possible to say: "It is at least worth that much, therefore, the project is acceptable from an economic point of view." Alternatively, if the cost-price is very high, the decisionmaker may say: "I cannot justify the value implied by the cost-price calculation. Therefore, I will not accept the project as being acceptable in economic terms and will reject it, or attempt to redesign it to reduce costs."

7.6 Dealing With Critical Factors Identified in the Sensitivity Analysis

Where a reasonable change in the assumption about the expected value for a given parameter (or values of a combination of parameters) is critical in terms of the expected outcome of a project, it is desirable to generate additional information about the parameter(s), if this is possible.[34]

[34]Again, *reasonable* here refers to an initial estimate of what the possible range in values might be. *Critical* in terms of project outcome refers to the point where a factor's value reaches its *switching value*, i.e., where the NPW moves from positive to negative or the ERR falls below the guiding rate of interest.

This may involve estimating the probabilities of different values occurring using statistical sampling techniques and available data. Or, it may merely involve developing subjective probabilities, or a number of other less formal approaches to getting more information about the likelihood or occurrence of the values that are critical to the project outcome.

Box 7.2. Breakeven analysis.

A plantation project is being planned. The analyst is fairly certain about the costs involved—\$250 for establishment in year zero and \$10/ha/a starting in year 1. Technical personnel are fairly sure about their estimates of average yields and optimum rotation. The expected yield is 428 m^3 on a 15-year rotation. Present stumpage value is \$5/m^3, but there have been fluctuations and the expectation is that demand pressure on the limited supply will push up the stumpage price in the future. The analyst is uncertain about the estimate of a stumpage value 15 years from now. (The analyst used an expected value of \$7/m^3 based on projection of past trends in real prices.) Given this uncertainty, one useful piece of information would be the stumpage value which would make NPW equal to zero at the relevant discount rate of 10 percent. The task for the analyst is to calculate this value, which is called the cost-price.

The analyst can approach the task dealing with future values (in year 15) or present values. Since it is easier (one less step) and makes more sense to deal with the future, the analyst approaches it by compounding values instead of discounting them. The analyst uses the following basic equation:

Establishment cost (C) compounded for 15 years
+ Annual costs (Ai) compounded for 14 years
= Price (P) x Yield (Y)

Since the analyst is solving for P, the equation is rearranged as follows:

$$P = \frac{C(1+i)^{15} + A\,\frac{(1+i)^{14} - 1}{i}}{Y}$$

$$P = \frac{(\$250)\,(1.10)^{15} + \$10\,\frac{(1.10)^{14} - 1}{.10}}{428m^3}$$

$$P = \$3.10/m^3$$

(Note: The compounded annual payment factor comes from Appendix B).

What this cost-price of \$3.10/m^3 means is that with other values as assumed, the costs of producing stumpage on this project, allowing for a 10 percent return on invested capital, is \$3.10/m^3. In other words, stumpage prices could be as low as \$3.10/m^3, and the project would still breakeven at 10 percent. Since the analyst and decisionmaker are quite certain that the price will be at least at the current level of \$5/m^3, they accept the project as having a good chance of obtaining at least the 10 percent return required for this type of project.

If the cost-price had turned out to be around \$6/m^3 (i.e., higher than the present price but lower than the analyst's estimated \$7/m^3), then the analyst might want to take a closer look at the project, treating it in one of the ways suggested in the following sections.

Technical personnel and available literature can be consulted to obtain estimates of parameter values and their ranges under varying conditions. More detailed effort can be spent on market surveys. Further, project planners often can find that a wealth of information on species characteristics and other properties of woods is available from national or international wood testing laboratories. Such information should be used to full advantage. Similar sources can provide information about biological production functions, insect and disease problems, etc. In most cases, data on which to base an objective probability analysis are lacking and cannot be generated in a short period of time. Yet, often considerable usable information is available for use in developing subjective probabilities.

If further information on the critical parameter(s) indicates that there is a reasonable chance (perhaps 1 in 20, or whatever is chosen) that the parameter(s) could indeed take on values which would influence the decision regarding a project, then the following project planning alternatives (which are not mutually exclusive) are available:

- change project design;
- build in contingencies and safeguards; and
- adjust the decision criteria used.

The first two of these possibilities are discussed below. The third relates to the broader issues surrounding project decisionmaking and is outside the scope of EAFP.

7.6.1 Changing the project design

It may be possible to reduce uncertainty by redesigning the project, e.g., changing its scale, changing factor proportions, integrating it with further processing or with raw material production. Or, flexibility may be built into the project by staging various project activities in a different way and with a different time schedule than initially planned, or by redesigning it to include more flexibility in terms of choice of factor inputs or outputs after implementation, etc.

Some examples will help illustrate how redesign can reduce uncertainty. If an initial project design is for project at a scale that would fully meet an estimated future market demand which is somewhat uncertain, then perhaps the project can be scaled down so that its capacity is near a lower estimate of market demand. This would reduce market uncertainty effects on the project. At the same time, if economies of scale are involved, it may increase cost. In this case the project planner has to weigh reduced uncertainty against higher costs. Or, it might be possible to redesign the project to start with a smaller capacity sawmill or plantation, and gradually build up capacity in phases as estimated future market conditions, factor availabilities, etc., become less uncertain. Other project design responses to uncertainty are possible (see box 7.3 for examples).

A few words of caution are needed concerning redesign. In most cases, if the initial project design was based on thorough analysis of alternatives, then it was likely considered to be an optimum design in terms of the criteria for judging project worth and contribution. If redesign is undertaken, it is likely that expected costs will be increased and/or expected returns reduced over the initial optimum design. There is a need to consider trade-offs between lower levels of uncertainty and lower levels of project worth (as compared with the expected return for the initial optimum design project). While the project planner can attempt to calculate and point out some of the trade-offs involved, it remains a matter of judgement as to the choice between alternatives. No general rules can be made, since it is difficult to quantify a decisionmaker's subjective weighting of uncertainty.

Box 7.3. Responding to uncertainty.

In response to uncertainty, investment in some of the fixed infrastructure, such as roads and buildings, could be delayed until the situation regarding future conditions became more certain. The potential impact of an uncertain market for one specific product could be reduced by expanding a forest industry project to include a more diversified output mix. For example, a sawmilling project could have a moulding production unit attached to it so there would be some flexibility in terms of shifting production from sawnwood to moulding as market conditions warranted. Diversification in plantation projects could also help to reduce uncertainty. For example, planting more than one species could help to reduce the risk of insect and/or disease problems in monoculture plantations. Species diversification could reduce future market uncertainty if the planted species have some overlap in characteristics and uses but also some unique characteristics which permit placing them in different markets as conditions warrant it. An example of a project which explicitly included this type of flexibility is the Korean fuelwood project; part of the area planted included *dual purpose* species which could be used for either fuel or timber, depending on how future market conditions developed for fuelwood.

Redesign is not the answer to all problems of uncertainty and should be approached cautiously. In many cases, redesign may not be desirable, and it will be necessary to resort to other methods of treating uncertainty. In some cases of uncontrollable uncertainty, redesign may not be possible in the context of the project objective, and other approaches may have to be used.

7.6.2 Building safeguards and flexibility into a project

Safeguards may be built into projects, including insurance on various elements of the project (which increases the project cost but reduces risk to the project entity); providing for physical contingencies (really a form of self-insurance); adding a premium to the discount rate used in calculating the NPV of the project, or arbitrarily lowering the output values and/or increasing the input cost estimates in calculations of the ERR or the NPV.

These approaches may not be sensitive to the uncertainties identified. For example, adding a premium to the discount rate penalizes future costs and benefits more than present or early costs and benefits, and this is not necessarily related to where the main uncertainties exist. On the other hand, an arbitrary increase in costs (e.g., contingency or insurance) and/or decrease in benefits would, for any given discount rate, suggest that uncertainty concerning future values is less important than uncertainty concerning present or early values. This may not be in keeping with the levels and timing of uncertainty identified. Despite their shortcomings the approaches suggested are used widely as a convenient way to reduce the chance of failure or a lower than expected rate of return. It essentially amounts to the same thing as saying that the acceptance criterion is made more stringent, i.e., a project has to show better than marginally acceptable performance. Adding a contingency allowance for physical uncertainty is likely to be the preferable way to treat the problem, since it does not tend to hide what is being done from the decisionmaker.[35]

Projects can be designed with specific contingencies in mind. For example, in the case of an industrial plantation project planned for Tanzania, it was recognized that a principle uncertainty

[35] See Gittinger 1982, for further discussion of contingency allowances.

facing the project would be that the yet-to-be built pulp and paper mill, which would use the wood, would not be built. Contingency plans for the project, in the unlikely event that the mill was not built, were (1) gradually to scale down the planting program and stop it after five years, and (2) grow the trees planted to a 25-year sawlog rotation instead of the shorter planned pulpwood rotation. The project analysis showed that there would be an acceptable market for the resulting volumes of sawlogs. The same type of contingency planning was included in the Korean fuelwood plantation program, by planting a part of the area with dual purpose trees, i.e., ones that could be used both for fuel and timber.

Two additional points should be mentioned about uncertainty. First, uncertainty is often associated with the objectives for a project and the appropriate criteria for measuring the contribution of a project toward meeting objectives. This topic is not discussed here, mainly because it fits better in a discussion of sector planning, i.e., it is a question that transcends the subject of planning a particular project, given an objective. Objectives for a given project should be derived from a more general evaluation of the present condition of the sector and what goals it should be moving toward. The main problem with objectives at the project level relates to lack of definition. There is no sense in planning projects and project alternatives if objectives are not first defined explicitly. Criteria follow logically if objectives are defined. However, there are cases where criteria are poorly specified, mainly because objectives conflict or are loosely defined. The uncertainty in such cases is related to the lack of specified trade-off functions for the various conflicting objectives. Sensitivity analysis can contribute information on which decisionmakers can base subjective judgements regarding trade-offs. The uncertainty involved really relates to uncertainty concerning the relative values placed on various objectives by society or decisionmakers.

Second, a logical question is, How much should be spent on reducing uncertainty? In general, the amount spent depends on the nature of the project and the available budget. In some cases, slight additional effort/expenditure can result in a marked reduction in uncertainty. In other cases, substantial expenditure will have little impact on reduction of uncertainty. Judgement based on past experience and knowledge about information availability and cost of information will provide some idea of the particular cost/benefit relationship facing the analyst. As illustrated in box 7.4, how much reduction of uncertainty is worth to the decisionmaker is a judgmental question which has to be answered for each case separately.

Box 7.4. The relative importance.

In the case of a plywood production expansion project in the upper Amazon, the project analysts and sponsors decided that the substantial uncertainty surrounding estimates of total wood availability in the region was not significant to project viability. Ample volume was known to be available for the project at acceptable cost, and even the lower limit estimate indicated an available volume large enough to provide an ample margin of safety for the project. On the other hand, in the case of an integrated sawnwood and pulp and paper project currently being designed in Honduras, a large amount of money is being spent for detailed inventories so the project sponsors can be more certain that an adequate volume of wood is available at acceptable cost before they decide on the scale of the processing facilities and commit large sums to plant, equipment and infrastructure. In this case, uncertainty surrounding wood supply and cost is considered a critical factor by decisionmakers.

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