MODULE 8

PROJECT APPRAISAL AND THE ENVIRONMENT

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8.1 ECONOMY-WIDE POLICIES AND PROJECT APPRAISAL

Modules 6 and 7 illustrated the linkage between environment and economics at the macro-policy and sectoral levels. It was shown how environmental economics helps assess the efficiency of macro and sectoral policies based on a comparison of costs and benefits. Cost-benefit analysis is a fundamental tool to provide decision-makers with objective economic information at all levels in the broad framework described in module 1: macro-policy, sector, programme and project. Comparing the costs and benefits of macro-economic policies will help identify monetary value of market and policy failures as well as the general efficiency of proposed or ongoing policies. Sectoral cost-benefit studies will help identify priority areas for interventions. Investments in programmes are then identified based on various criteria, including a comparison of costs and benefits. Programmes can be seen as an aggregate of projects: a series of forest plantations, several irrigation projects, access roads, housing development, a fleet of taxis adding catalytic converters etc. A parallel effort at the project level is needed to improve incrementally budgetary allocation toward more environmentally and socially sustainable development projects. This module is focused at the project level but the concepts are applicable at the sectoral and policy level. One challenge however, is to capture the environmental costs and benefits of macro-policies, and sectoral policies and investment programmes within the broader cost-benefit analysis Module 9 provides methods of valuing environmental impacts and environmental goods and services that lack market prices. Module 10 focuses on environmental impact assessment.

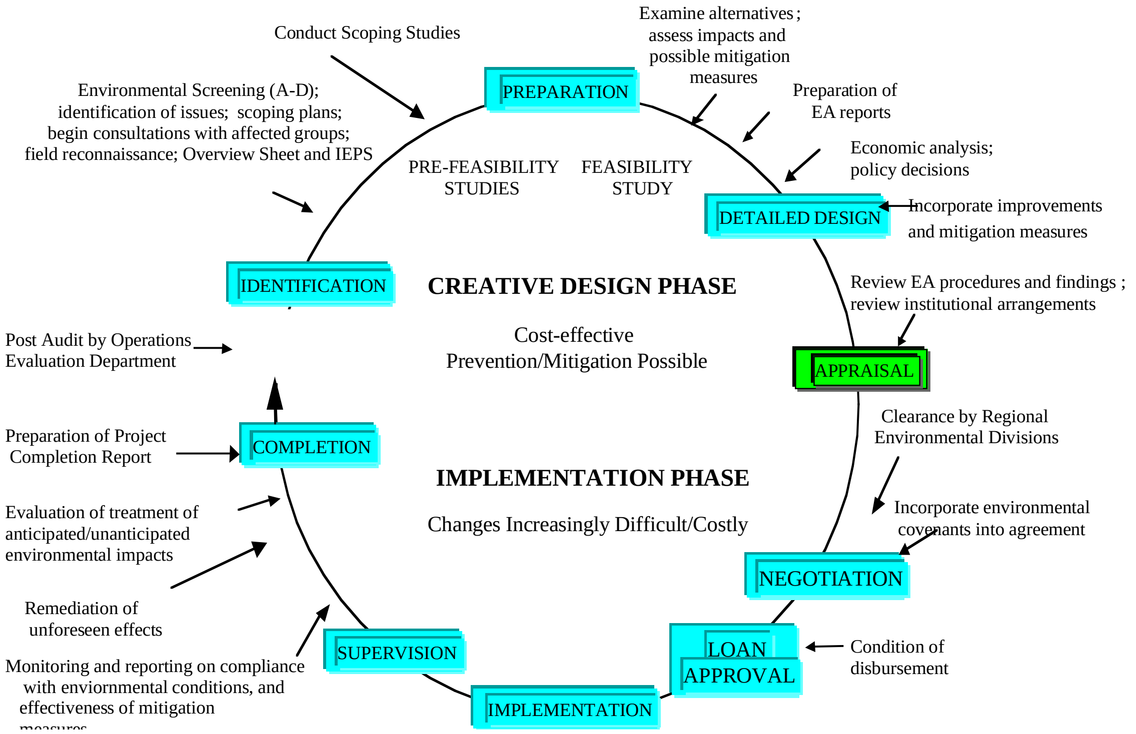
8.2 THE PROJECT CYCLE AND ENVIRONMENTAL IMPACTS

The project cycle has six general steps:

- Project identification *(what projects should we do?);*
- Pre-appraisal of project *(is the project feasible from an early assessment?);*
- Preparation of project *(more detailed planning, organising, etc);*
- Economic, social and environmental appraisal *(doing a full feasibility study);*
- Project implementation *(build it, do it, etc.); and*
- Monitoring and evaluation *(how did we do; did we meet objectives, etc?).*

This module mostly reviews the full appraisal step, but as an integral part of the cycle. Environmental considerations should be integrated early on in the project cycle to focus directly on sustainable projects. Early environmental assessment[1] is important but other environmental considerations persist all along the circle (Figure 8.1). The figure reflects the project cycle used by the World Bank and copied by most other development banks (African Development Bank for example). Within a country or a private organisation, a more simplified project cycle could exist.

Figure 8.1: Environmental assessment and the project cycle



Public sector investment project identification is often tied to a country's planning and budgeting cycle. How projects are identified is important. Have projects been put forward by central planning Ministries, or are there small but innovative ideas from the beneficiaries themselves, for example communities? A top-down approach can often lead to project failure because the beneficiaries have no sense of ownership. At the same time, a pure bottom-up approach can lead to projects being formulated without any national context. Projects should address national development goals as specified in country development plans and strategies. A balance is needed between identifying projects based on national priorities and local needs.

[1] Refer to module 10 for material on environmental assessment.

8.3. BASIC PROJECT APPRAISAL CONCEPTS

8.3.1. Background

Resources are limited. All organisations have to make choices regarding the allocation of human and financial resources for project investments. The appraisal process covers four general situations. **First** is where a single project is being proposed and appraised. Development Banks and large companies undertake this type of analysis all the time. The investment funds are available. The appraisal simply helps determine if the investment is viable, usually according to quantitative financial criteria.

A **second** case is where an organisation has different competing projects for investment and inadequate resources to do them all. The projects are not mutually exclusive; if sufficient funds were available, all the projects could be completed. Investing in one project would not preclude investing in others. An example would be a mining company with a portfolio of 15 capital investment projects at the beginning of the financial year and insufficient funds to invest in all of them. The projects could include buying new drilling machinery, setting up a new computer system, or pursuing joint ventures with smaller mining companies to increase ore reserves. Each project can be appraised and then compared in terms of standard financial criteria. The projects can then be ranked with investment funds allocated to the projects in order of priority (Convery 1995). This is a typical capital budgeting process. An extension of this model is where an organisation has a large number of similar projects and must allocate scarce resources. An example is a government Forestry Commission with 25 potential reforestation projects totalling 450 hectares and only enough resources to do 350 hectares. An appraisal process can rank the separate projects according to investment criteria to help managers make better investment decisions. Site productivity and slope would come into play as these influence forest growth rate and yield. Location to processing mills would also be important as it influences transport costs of logs and hence net returns.

A **third** case is where projects are mutually exclusive. For example, with a given area of bare land, an investor must choose between forestry, agriculture or perhaps urban development. Selecting one option precludes the other. Each project is appraised individually and compared. A **fourth** case is where a project has already been selected (for political reasons usually) and the appraisal is used to help determine the best method of implementation. This situation is very common in developing countries.

Six general steps are recognised in analysing an investment (or appraising a project) using quantitative methods:

- Ensure that clear project goals address broader strategies and policies;
- Identify, quantify and schedule inputs and outputs (costs and benefits);
- Assign values to them and prepare cash flows (- and +);
- Compare costs (-) and benefits (+);
- Evaluate uncertainty and risk; and
- Weigh the economic and financial criteria with other objectives and criteria.

In carrying out these steps, three basic concepts must be addressed.

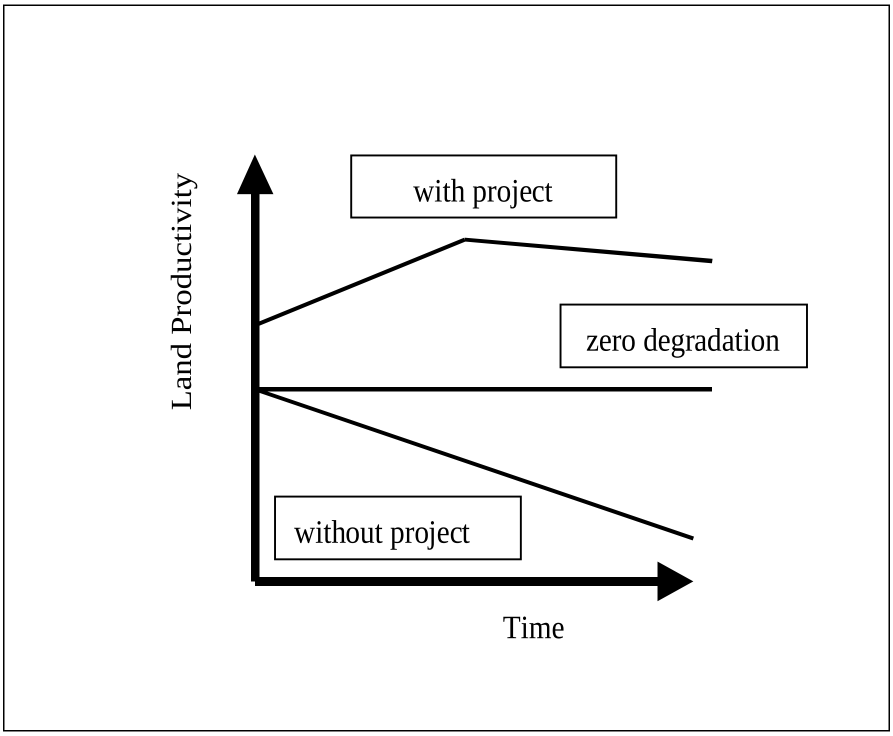
- Using a “with-without” project framework;
- Knowing the difference between a financial and economic appraisal; and
- Using a discount rate to put all costs and benefits into a common time period (for quantitative methods that are based on efficiency criteria).

8.3.2. With-Without Project Framework

Projects should be appraised on their net marginal benefits to an individual or society. Marginal benefit means that the investment proposed should improve on what would happen without that investment. The analysis focuses on the incremental change in net benefits. For this reason, marginal investment analysis is also referred to as a with-without (the project) analysis. The with-without analysis principle is particularly useful in assessing the environmental impacts of projects. The economic impact of a project is the difference in present value with and without the project alternatives.

The with-without the project situation should also consider changes that would naturally occur without the project. For example, a forest may continue to be degraded without any project intervention. As another example, the expected decrease in soil productivity for agriculture should be considered when appraising projects on an area where marginal agriculture and grazing are taking place and for which yields will decrease over time (Figure 8.2). The figure shows a horizontal trend line for land productivity in the absence of degradation. With the project, degradation is reduced for a period of time and then declines in response to higher population pressure, etc. Land degradation is not eliminated. Without the project, the situation is much worse.

Figure 8.2: With-without analysis, land productivity example



Traditional investment analysis only integrates marginal physical inputs and outputs underlying the cash flows that are priced in the market. Any other inputs and outputs, mostly related to environmental resources are frequently not measured, especially for private investment purposes. An appraisal can however, be extended to try and capture the marginal environmental changes from the project. The main differences between an analysis that captures environmental impacts and one that does not are summarised in Table 8.1.

Table 8.1: Appraisal of projects with and without environmental impacts

Steps in Analysis	*Project With Env. Impacts*	*Without Env. Impacts*
1. Inputs and outputs	Direct production	Production function plus an Environmental Assessment (expand the physical analysis in space and time)
2. Valuation	Market prices or shadow prices correcting mostly for policy failures	Shadow prices rectifying for policy but also market and institutional failure
3. Net benefits	Use Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost criteria together with risk analysis	Mostly NPV kind of criteria, but also cost effectiveness, with an appropriate rate of discount and often an unlimited time span, together with uncertainty analysis.
4. Decision Making	Efficiency objective	Efficiency plus social and environmental objectives balanced through participation

8.3.3. Financial and Economic Analysis in Quantitative Appraisals

A financial appraisal looks at a project investment from an individual point of view, while economic analysis takes a societal point of view. Financial and economic values are similar if there is no policy failure. The main differences between a financial and economic analysis are shown in Table 8.2. The usual approach is to begin with a financial analysis and then undertake a broader economic analysis. Companies tend to focus on financial analysis. Governments and development banks tend to do both levels of analysis.

A great deal of literature exists on the need to adjust prices in an economic analysis to reflect consumers' willingness to pay (WTP). In theory, a perfectly competitive market provides the "right" values for goods and services in that market, given existing policies affecting WTP.

In the case of input values or costs, the term opportunity cost is often used; it is the value forgone by not being able to use the input in its next best alternative and it is measured in terms of consumers' WTP for the goods and/or services forgone. So for both inputs and outputs, WTP should be the basis for valuation in economic analysis. In the real world however, prices are often distorted by policy failures including:

- Minimum prices or price ceilings (price controls);
- Quotas or subsidies for production, imports or exports;
- Monopoly or monopsony, oligopoly of oligopsony;
- Speculation on market prices; and
- Exchange controls.

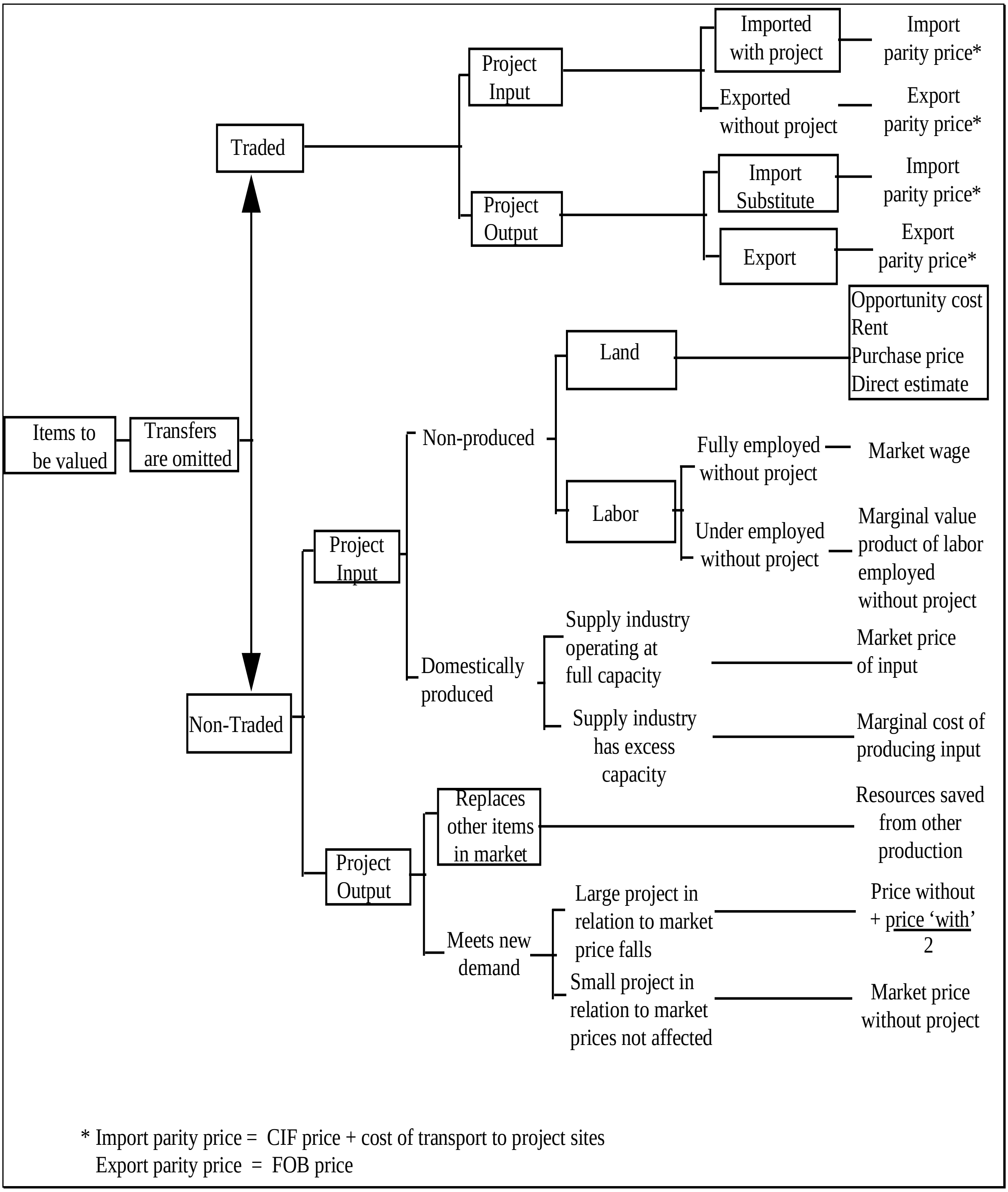
Table 8.2: Financial and economic analysis

	Financial Analysis	***Economic Analysis***
Point of View	Net returns to equity capital or to private group or individual	Net returns to society
Purposes	Indication of incentive to adopt or implement	Determine if government investment is justified on economic efficiency basis
Prices	Market or administered (may assume that markets are perfect or that administered prices have compensated for imperfections)	May require "shadow prices" (e.g., monopoly in markets, external effects, unemployed or underemployed factors, overvalued currency)
Taxes	Cost of production	Part of total societal benefits
Subsidies	Source of revenue	Part of total societal cost
Loans	Increase capital resources available	A transfer payment: transfers a claim to resource flow
Interest or loan repayment	A financial cost: decreases capital resources available	A transfer payment
Discount rate	Marginal cost of money: market borrowing rate	Opportunity cost of capital: social time preference rate
Income distribution	Can be measured re: net returns to individual factors of production such as land, labour, and capital	Is not considered in economic efficiency analysis. Can be done as separate analysis or as weighted efficiency analysis

Where market prices are distorted, "shadow" prices may have to be approximated for what they really would be if the right polices were in place. Shadow prices may be higher or lower than market prices. Shadow pricing techniques were pioneered by Little and Mirlees (1974) to facilitate more effective project appraisals in most developing countries, which at that time were plagued by state market controls. In the past decade, many of these distortions have melted away as countries implement economic reform programmes. This means that for many projects, little if any adjustments may be required. In practical terms, the actual market prices, (sometimes local, often international) are taken as a good approximation of economic values. The need to calculate shadow prices at the project level will depend on the level of price distortion and the relative importance of a specific input or output in the project. Also, if the project will have a major impact on output supply (or demand for certain inputs), this could cause price distortions. For minor inputs or outputs however, why waste your time deriving shadow prices? With more critical inputs and outputs, how can you avoid shadow pricing? In some countries, shadow prices may already be calculated[2] for important inputs or outputs. Development banks also routinely derive shadow prices and conversion factors. These conversion factors can then be applied to similar inputs and outputs. In these cases shadow pricing may be needed (Figure 8.3).

[2] One example is Ethiopia where the central Planning Ministry has derived correction factors (or in the jargon - standard conversion factors) for many key project inputs and outputs.

Figure 8.3: Decision tree for deriving shadow prices for traded and non-traded inputs and outputs[3]



[3] Refer to Annexure 1 in this module for examples of adjusted prices.

As a final word on shadow pricing, it is wise to heed the following thoughts, condensed from Convery (1995):

Basic conditions for ignoring shadow pricing include official exchange rates that are close to the market rates, market clearing prices for most goods and services (few import or export quotas), and competitive markets. Where these conditions do not apply, you could get caught in a morass of shadow pricing from which, after much work you emerge with results that lack credibility. Some of the shadow pricing only makes sense if it is applied throughout the economy and most economists appraising projects are not in a position to do so. Rather than agonising over minor adjustments to financial prices, professional time may be better spent considering policy structures, incentives and cost-effectiveness surrounding the proposed investment.

Taxes and interest sometimes cause confusion in project appraisal. In an economic analysis, cash flows ignore transfer payments such as taxes and interest paid within society. The reason is that transfers do not use resources per se, but are just payments from one group to another, within a defined society. In environmental economics, many costs and benefits are evaluated at the global level. In this case, even interest on loans paid outside of a country are considered transfers. The correction of prices for transfer payments may have important impacts on resources used and the environment.

8.3.4. Selecting a Discount Rate for Quantitative Appraisals

Most quantitative appraisal methods require adjusting cash flows for the effect of time. A dollar now is worth more than the promise of a dollar to be paid in the future. Why? Having a dollar now allows you to invest the cash or spend it on current consumption rather than having to wait for these opportunities. Waiting to receive a project benefit in the future implies an opportunity cost. Similarly, current investment in project costs implies an opportunity cost of the alternatives given up by making the investment. The cost of time has to be accounted for and this is done through discounting. The usual practice is to discount all cash flows occurring at different times over the life of the project (benefits and costs) back to the present for comparison[4].

[4] Refer to Annexure 2 at the end of this module for basic information on discounting.

To compare the benefits and costs of an investment over time, especially long-term environmental investments, the discount rate is crucial. The appropriate discount rate to use for an economic analysis, especially where the project has environmental impacts is a controversial topic. Two principal schools of thought exist, each with a long list of supporting literature. The first argues that all investments should use the opportunity cost of capital as the discount rate. In other words, what is the rate of return your funds could earn in the next best alternative? If you can earn 15 percent in the money market, that is your opportunity cost of capital and discount rate. The **opportunity cost** approach is predominant in the private sector.

The second approach argues that society is myopic and tends to have a short time horizon. On the basis that a discount rate emulating the "private sector" opportunity cost of capital favours short-term investments, some people argue that certain situations require a lower discount rate. This is the **social time preference** rate. A lower rate would accommodate longer-term projects, often by the public sector and where the private sector might not wish to invest. Environmental projects often fall into this category. As an example, investing in reforestation projects where trees need 80 years to mature will usually lead to negative net returns based on prevailing market (opportunity cost) discount rates. Using a lower, social time preference rate might make the investment economically viable. Another reason for governments using a lower discount rate is risk pooling. Governments undertake many projects, some of which fail. The loss to investors (members of society) is spread out and therefore small for any individual.

What is a practical solution[5] to selecting a discount rate? One approach is to use prevailing market rates (opportunity cost of capital) as the discount rate in the financial analysis. This would certainly be appropriate for private sector investments. A social time preference rate could then be applied to the broader economic analysis.

Another approach is to find if your country has an official discount rate for public sector investment projects. Often, central Planning Agencies or Ministries of Finance have an official discount rate, usually a social time preference rate, to apply to public investments. Ethiopia and Zimbabwe are good examples.

[5] Refer to Annexure 3 at the end of this module for advanced material on discount rates.

A third approach is to simply apply the discount rate used by international development banks in their project appraisals in developing countries. As an example, the World Bank tends to use a discount rate of between 10 and 12 percent.

What about inflation? All the values in the cash flow tables, financial as well as economic, should be in real terms. It is extremely difficult to assess inflation over a long time span. The usual method is to hold prices constant over time and use a real discount rate. The difference between a real and nominal discount rate is important for long term projects, especially where environmental impacts have to be valued and discounted. In practical terms, the real discount rate is simply the nominal discount rate less the rate of inflation. Thus, if nominal interest rates are 20 percent and inflation is 10 percent per annum, then the real discount rate is 10 percent (20% less 10%). More precise methods of deriving a real discount rate exist however (Box 8.1).

Box 8.1: Calculating Real Discount Rates

$$(1+n) = (1+f)(1+r)$$

where: n = nominal (inflated discount rate)
r = real discount rate
f = average annual percentage rate of inflation

Using the previous figures from the text:

$$(1+0.20) = (1+0.10) \times (1 + r)$$

$$1.20 = 1.10 \times (1 + r) \qquad \frac{1.20}{1.10} = 1 + r \qquad r = 9.09\%$$

8.4 PROJECT APPRAISAL THAT COMPARES COSTS AND BENEFITS

8.4.1 Net Present Value (NPV)

a) Description

Net present value is probably the most common approach for appraising projects using discounted cash flows in both the private and public sectors. The present value of all benefits is compared to the present value of all costs. Alternatively, net cash flows are first calculated for each year of the project and then discounted to the present. NPV requires the selection of a discount rate. The final result is a numerical value in specified currency units.

b) Decision criteria

For a single project, acceptability requires that NPV > 0. This would reflect a project where the present value of incremental benefits exceeds the present value of all capital and recurrent costs. For a capital budgeting process, where multiple projects are being appraised and limited budgets mean that some projects cannot be funded, NPV can be used to rank projects in order of priority. The objective is maximisation of NPV. Where budget rationing exists, NPV is probably the preferred method of appraising projects. NPV addresses efficiency objectives.

c) Example

A simple reforestation project is given in Box 8.2 and 8.3. Box 8.2 provides background information on the project: costs, benefits, timing and discount rate. Box 8.3 shows the annual cash flows and two ways of deriving NPV (taking the difference of the PV of costs and benefits, or the PV of the net annual cash flows. All cash flows are assumed to occur at the end of each year. A spreadsheet programme (in this case Excel) was used to calculate NPV.

Box 8.2: Basic Project Information

1. Initial capital costs in first year	
a) land clearing	350
b) nursery costs for seedlings	50
c) land preparation	40
d) tree planting	40
e) road access to site	120
Sub-Total	**600**
2. Annual plantation costs	
a) protection from fire, insects	4
b) maintenance (weeding)	6
c) administration/overheads	30
d) estate manager	200
Sub-Total	**240**
3. Felling costs in year 10	**1200**
4. Timber revenues in year 10	
a) 85 m3 of poles @ $125/m3	**10625**
5. Discount rate (%)	**14**

Box 8.3: NPV Calculation

Appraisal	**Results**				
Year	Capital Costs	Annual Costs	Felling Costs	Gross Revenues	Net Cash Flows
1	-$600	-$240	$0	$0	-$840
2	$0	-$240	$0	$0	-$240
3	$0	-$240	$0	$0	-$240
4	$0	-$240	$0	$0	-$240
5	$0	-$240	$0	$0	-$240
6	$0	-$240	$0	$0	-$240
7	$0	-$240	$0	$0	-$240
8	$0	-$240	$0	$0	-$240
9	$0	-$240	$0	$0	-$240
10	$0	-$240	-$1,200	$10,625	$9,185
PV	-$526	-$1,252	-$324	$2,866	

8.4.2 Benefit Cost Ratio

a) Description

The benefit-cost ratio (BCR) is derived from the information compiled when calculating NPV. The BCR is the ratio of benefits per dollar of cost (both in PV terms). The BCR is a numerical value, not usually displayed in currency terms. The formula is simply:

$$BCR = \frac{\text{PV of benefits}}{\text{PV of costs}}$$

b) Decision criteria

For individual projects, the acceptability criteria is for the BCR > 1. Projects should be rejected where the BCR < 1. For mutually exclusive projects or where we want to rank similar projects (with limited budgets), the BCR is usually used in conjunction with NPV. In this case, NPV is the first decision criteria and BCR can show relative efficiency among projects.

c) Example

Using the information from the forestry project, the BCR is 1.36 (Box 8.4)

Box 8.4: Calculation of BCR

PV of all costs (capital, recurrent and felling) = \$526 + \$1252 + \$324 = \$2102

PV of all benefits = \$2866

$$BCR = \frac{\text{PV benefits}}{\text{PV costs}} = \frac{\$2866}{\$2102} = 1.36$$

8.4.3 Internal Rate of Return (IRR)

a) Description

The IRR (alternatively called the rate of return, or return on investment) is the discount rate for a project that will result in a NPV = 0. In other words, the IRR is the rate at which the PV of measured benefits equals the PV of measured costs. Where IRR is used in a broader economic analysis, the term "economic IRR" or EIRR is often coined. Unlike, NPV, where a discount rate must be selected, the IRR derives a percentage value representing the rate of return on the project. IRR can be used to appraise individual projects, or provide information to help make decisions about appraising and ranking multiple investment opportunities.

b) Decision criteria

With individual projects, the appraisal must compare the IRR with a pre-selected rate of return, often called the hurdle rate. This hurdle rate usually represents the organisation's cost of capital. The objective then is for the project to earn an IRR equal to or greater than this "hurdle rate". If an organisation is using the World Bank's opportunity cost of capital of say, 12 percent, and the project has an IRR of only 8 percent; the project would be rejected. If on the other hand, the project IRR were 15 percent, it would be accepted on this criterion. For mutually exclusive projects or where we want to rank similar projects (with limited budgets), the IRR is usually used in conjunction with NPV. In this case, NPV is the first decision criteria and IRR can show relative efficiency among projects. Most spreadsheet packages include a financial function to calculate IRR. Manual calculation can be done, but is time consuming and not as accurate.

c) Example

Using the same forestry example, the IRR is 20 percent (Box 8.5)

Box 8.5: IRR, Forestry Plantation

Appraisal	**Results**				
Year	Capital Costs	Annual Costs	Felling Costs	Gross Revenues	Net Cash Flows
1	-$600	-$240	$0	$0	-$840
2	$0	-$240	$0	$0	-$240
3	$0	-$240	$0	$0	-$240
4	$0	-$240	$0	$0	-$240
5	$0	-$240	$0	$0	-$240
6	$0	-$240	$0	$0	-$240
7	$0	-$240	$0	$0	-$240
8	$0	-$240	$0	$0	-$240
9	$0	-$240	$0	$0	-$240
10	$0	-$240	-$1,200	$10,625	$9,185
PV	-$526	-$1,252	-$324	$2,866	
IRR					20%

8.4.4 Minimum Payback Period

a) Description

Unlike the previous methods, payback does not have to involve discounted cash flows. The value of time is therefore not captured. Instead, the objective is to determine the length of time required to recover costs from the flow of benefits over the project life. The major disadvantages of this approach are first, as noted, the opportunity cost of time is ignored, and second there is no linkage between the payback period and the organisation's cost of capital. Despite these limitations, the payback period is used in both the private and public sector. Advantages are that it is simple, requires little information, and links the project to liquidity, that is the project's ability to earn cash. It is usually applied to compare and rank competing projects.

b) Decision criteria

The decision criterion is to minimise the payback period.

c) Example

The forestry example does lend itself to the payback method because income is only earned at the end of the 10-year period. In this case, the payback period is 10 years. The payback method is more applicable to projects that earn income over time, in addition to any final earnings. An example is shown in Box 8.6.

Box 8.6: Calculation of Payback Period

Year	Project Costs	Project Benefits	Net Cash Flows	Cumulative Cash Flows
1	100000	0	-100000	-100000
2	40000	30000	-10000	-110000
3	20000	35000	15000	-95000
4	45000	40000	-5000	-100000
5	15000	45000	30000	-70000
6	15000	50000	35000	-35000
7	15000	55000	40000	5000
8	10000	50000	40000	45000
9	10000	45000	35000	80000
10	10000	40000	30000	110000

The method requires calculating net cash flows and then an additional column called cumulative cash flows (CCF). The payback period is where the CCF = 0. From the example, this point is reached somewhere between year 6 and 7. At the end of year 6, another $35,000 is required to bring the CCF to zero in year 7. In year 7, the project earns $40,000. A simple ratio of 35,000/40,000 gives 0.875. Thus the payback period for this project is 6.875 years, or approximately 6.9 years.

8.5 PROJECT APPRAISAL METHODS THAT FOCUS ON COSTS

8.5.1 Cost-Effectiveness Analysis (CEA)

a) Description

As mentioned earlier, sometimes projects are already approved for political reasons, without a proper appraisal. As well, some projects may have benefits that are difficult to measure, for example in projects dealing with biodiversity or conservation. In these cases, project goals may be clear but traditional cost-benefit analysis cannot be undertaken. The objective is to implement the project using the most effective and cost-efficient method. The CEA approach usually compares alternative means of achieving the goal in terms of least total cost. Potential applications include devising the least-cost method for reducing pollution to specified standards, determining the best use of a fixed budget for conservation projects, or generally assessing alternative means of achieving project goals (Winpenny 1991).

b) Decision criteria

The decision criterion is to select the least-total cost method of achieving project goals.

c) Example

CEA requires that capital and recurrent costs are included in the analysis. An example of a proposed National Park is provided in Box 8.7.

Box 8.7: CEA of Proposal National Park

Two options exist for developing a national park that will ensure conservation of various biological resources. The park would expect 100,000 visitors a year and have a life span of 50 years. To amortise the initial capital costs over the 50 years, a 10 percent discount rate is applied. The details are:

Option A: capital cost = \$2.0 million, recurrent cost = \$50,000/annum
Option B: capital cost = \$2.5 million, recurrent cost = \$18,000/annum

Amortised capital cost = capital investment x $[(0.10) \times (1.10)^{50}/(1.10)^{50} - 1.00)]$

Option A:	Annual capital cost	= \$201,800/annum
	Recurrent cost	= \$50,000/annum
Total cost		= \$251,800/annum or \$2.52/visitor
Option B:	Annual capital cost	= \$253,169/annum
	Recurrent cost	= \$18,000/annum
Total cost		= \$270,169/annum or \$2.70/visitor

The decision is to select method A because of lower total cost per visitor

Source: adapted from Convery (1995).

8.5.2 Break-Even Analysis

a) Description

Break-even analysis is an extension of cost-effectiveness analysis and can be used to choose the best method of implementing a specified project. Like CEA, it is applied to projects where benefits are difficult to measure or are already selected for political reasons. The main applications of break-even analysis are where projects cover an area or a linear distance. Examples could include tree planting, building access roads, rehabilitating river banks, and building hiking trails. Break-even analysis determines the area or distance where two alternative methods for the project have equivalent total costs (including capital and variable costs). Break-even analysis has many limitations. First, it must assume a linear variable cost function. Second, only two methods can be compared.

b) Decision-criteria

Depending on the budget allocated for the project, the method selected will either be above or below the break-even point. The least cost solution will be accepted.

c) Example

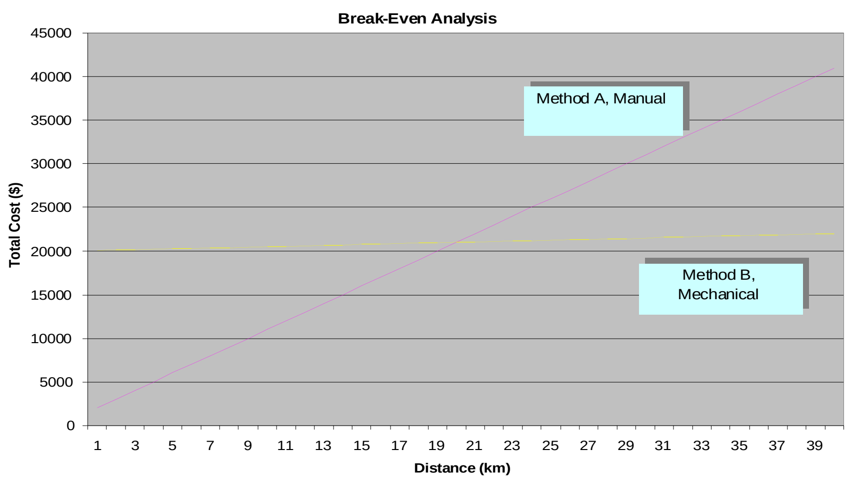
A simple example (Box 8.8) of a project to select the least-cost method for rehabilitating river banks is used to illustrate break-even analysis.

Box 8.8: Break-Even Analysis For a River Rehabilitation Project

Method A: manual clearing
fixed cost = $1,000, variable cost = $1,000/km
total cost = $1,000 + $1,000 N (where N = distance cleared)
Method B: mechanical clearing
fixed cost = $20,000, variable cost = $50/km
total cost = $20,000 + $50 N (where N = distance cleared)

Break-even point (solve for N with two equations)
$1,000 + $1,000 N = $20,000 + $50 N, 950N = $19,000 N = 20 km

If budgets allow less than 20 km to be done, use method A; above 20 km use method B



8.6 MULTI-CRITERIA DECISION MAKING IN PROJECT APPRAISAL

8.6.1 Background

Valuation techniques seek to estimate environmental impacts in economic terms. Often, projects or policies and their impacts are embedded in a system of broader (national) objectives, e.g., defined by social and ecological concerns of the type discussed in the introduction. To the extent that the impacts of projects and policies on these broader objectives may be valued economically, all such effects can be incorporated into the conventional decision-making framework of cost-benefit analysis. Quantitative appraisal methods such as NPV and IRR are well suited to this situation. However, some social and biophysical impacts cannot be easily quantified in monetary terms. Multi-objective decision-making offers a complementary approach. There are at least three reasons for presenting decision-makers with non-economic decision criteria:

- The decision maker's objective may not (or not only) be efficiency in resource allocation (for example maximising NPV);
- Efficiency might be too abstract a concept for people to base their decision on; and
- Frequently there is not enough information to value environmental impacts and other criteria in a financial/economic analysis.

Since many social and biophysical impacts cannot be easily quantified in monetary terms, "multi-criteria analysis" (MCA) may offer a practical approach to including environmental and social objectives in project analysis. MCA differs from economic analysis in three major ways:

- It does not limit project analysis to the economic efficiency decision criterion;
- It allows other criteria including environmental impacts to be measured in non-economic as well as monetary terms; and
- It does not require the use of monetary valuation to include various criteria in the decision making process.

8.6.2 Steps in MCA

There are typically four major steps in carrying out a MCA:

- Specifying general project objectives and project alternatives;
- Selecting appraisal criteria and assessing alternatives;
- Specifying the decision-maker's system of preferences, usually by assigning relative weights (priorities) to each criteria; and
- Identifying the global performance of alternatives, which in some cases will lead to choosing the best project alternative and in other cases to ordering alternatives by their associated level of global performance.

8.6.3 Specifying Objectives

The first step to including multiple criteria in project appraisal is to clearly specify the objectives of the project. Specification often exhibits a hierarchical structure, with the highest level representing broad objectives (for example, improving the quality of life), that are vaguely stated and not very operational (Munasinghe, 1993). These must be broken down into more operational lower level objectives (such as increasing income), so that the extent to which they are met by the project can be assessed. Specifying objectives at the outset of the analysis can save considerable time and resources. Bringing stakeholders[6] together in a workshop and using participatory methods can help reach consensus on objectives.

8.6.4 Identifying Criteria

Criteria are the attributes used to measure progress in achieving objectives. As with the setting of objectives, the selection of criteria is best done by building consensus among the stakeholders. If stakeholders are not involved in selection of criteria, the analyst's selection of criteria will require considerable value judgement. There are two types of criteria: (a) quantitative, and (b) qualitative.

[6] Stakeholders include individuals or groups of individuals that are positively and negatively affected by a project.

For quantitative criteria, the simpler and more tangible the units, the easier they will be for decision-makers to understand. Qualitative criteria require greater value judgement on the part of the analyst, because they are more subjective. Once criteria are chosen, each project alternative must be judged against these. Suppose there is a project to reduce air pollution in Cape Town, South Africa. One of the objectives of the project is to improve visibility of Table Mountain, the towering and scenic escarpment located north of the city. When comparing project alternatives, a quantitative criterion for this objective could be the number of days per year the top of the mountain can be seen from the city. A qualitative criterion is whether visibility is expected to be high, medium, or low for each alternative.

Criteria are combined with the project alternatives in a decision matrix. For example, suppose that three project alternatives (A, B, and C) are being considered for a new National Park (Table 8.3). Up to this point the decision criterion has been NPV (row 1) and the objective is maximisation of economic returns. Suppose now there are two additional objectives: (a) to provide the public with a recreational experience, and (b) to conserve an endangered ecosystem. The appropriate quantitative criteria for these objectives might be: (a) the number of recreation days enjoyed at the site per year (row 2), and (b) the area protected, measured in hectares by the project (row 3).

Table 8.3: Decision matrix for a national park development project

Decision Criteria	Project A	Project B	Project C
Net Present Value ($)	100,000	500,000	250,000
Recreation Experience (days/year)	50	10	25
Protected Area (ha)	100	500	250

8.6.5 Decision-Making with Quantitative Criteria

Once quantitative criteria have been set and assessed, the analyst must present this information to the decision-makers. Analysts use two sets of broad decision rules for MCA:

- First is to identify the dominant unweighted alternative, and if there is no dominant alternative then to identify non-inferior alternatives; and
- Second (explained in the following section) involves using weights and converting all criteria to the numerical units and then aggregating across criteria. The latter is less intuitive because it requires making assumptions about how the criteria are converted to another unit. This second approach is called Multi-attribute Analysis (MAA).

a) Decision-making with dominance

A dominant alternative exists if one project alternative is better than the other alternatives in some respects, and at least as good as each of the others in all respects. That alternative is said to dominate the set of project alternatives. The first decision rule is to always select the dominant alternative. In the example of decision matrix provided in Table 8.3, there is no single dominant alternative. Although project B is better than project A and project C in terms of net present value and area preserved, it is not as good as either project A or project B in terms of recreational experience.

A project alternative is said to be non-inferior if there is no alternative that dominates it, i.e. the other alternatives may be better in some respects but worse in other respects. In this case there is no decision rule for selecting among non-inferior alternatives, the only advice the analyst can offer is to avoid the inferior alternatives.

Going back to the example in Table 8.3, project B is better than C with respect to the criteria Net Present Value and land area set aside. Project A is better than B and C with respect to recreational experience. But project B is worse than C with respect to recreation and project A is worse than C with respect to Net Present Value and area preserved. If ranking alternatives does not allow these simple decision rules, the analyst may attempt to set weights and use a MAA technique and/or organise a participatory process to facilitate the setting of priorities.

b) Decision-making with no dominance

When no simple dominance exists, weights can be assigned as a first step in placing numerical values on each criterion. Weighting is complex since not only must the experts know exactly what the value placed by the society on the different impacts of the project is, but they also should be able to translate them into relative weights. Let us assume, for example, that we know that society places a higher value on water quality than on intensive agriculture. The problem is by how much should the relative weight of water quality be higher than intensive agriculture? The weight should be specified such that it reflects the relative importance attached to the marginal percentage change in environmental quality by the project in question. Options for assigning weights are shown in Box 8.9.

The second step in MAA is to assemble the quantitative values of each single criterion in one or more indicators that will help the decision-makers in the final choice. For each criterion, a means of scoring must be developed. As an example from Swaziland (Milne 1999), the following criteria were identified by Economic Planners to potentially appraise public investment projects in infrastructure:

- Number of people who will benefit;
- Environmental impacts;
- Location of projects;
- Level of local empowerment; and
- Investment and recurrent costs.

With these criteria, establishing a process for stakeholders to review the criteria and assign some type of numerical score was not felt to be difficult in practice. Similarly, a simple delphi process could be used to derive weights for each criterion from stakeholders. However, the challenge is to link each criterion to a specific scoring regime. In a scoring system based on 1-5 (with 1 being worst and 5 being the best), participants need information to know what a particular score means. With the first criteria, number of people who will benefit; what warrants a score of 5, or 3 or 1? What do we mean by "people who will benefit"? The location of projects was felt to be important, but location relative to what?

Box 8.9: Weighting Techniques for MCA

Delphi Method: weights are decided by a group made up by decision-makers, representatives of the collectivity and experts (economists, sociologists, environmentalists, biologists, agronomists, etc.). The procedure consists in preparing questionnaires that are submitted by the group to experts and representatives of the collectivity, who will elicit their preferences independently. Once the results have been analysed, a second questionnaire is prepared aimed at obtaining more precise data and information. This interactive procedure can continue until the point where answers to the questionnaire are constant and consistent with the previous questionnaires.

Paired Comparison Technique: with this technique, the weights are estimated on the basis of a simple procedure that takes into account three possibilities. a) One impact is more important than another. In this case it has a coefficient of 1. b) One impact is less important than another. In this case it has a coefficient of 0. c) The two impacts have equal importance. In this case the coefficient for both is 0.5.

Project Impacts	Coefficients						Total	Weight
	AB	AC	AF	BC	BF	CF		
A	1	1	1				3	0.50
B	0			1	1		2	0.33
C		0		0		1	1	0.17
F			0		0	0	0	0.00
Total							6	1.00

In the table above, A B C are the impacts for which weights must be established. F is an imaginary impact that allows to attribute to the other impacts a value > 0.

AB AC AF BC BF and CF are the compared impacts. The first row means that A is more important than B, C and F. The sum of the coefficients in each row gives the importance of the specific impact. For example, the value 3 in the first row is the importance of impact A. Finally the weights are computed by dividing the importance of the impacts (3 for impact A) by the total number of paired comparisons (6 in the table.

Opposed Pairs: in this case the weights are established on the basis of the characteristics of the environmental resource which can be scarce/abundant, renewable/depletable, strategic/non-strategic, etc. and on the basis of the type of impact, which can be long/short term, reversible/irreversible, direct/indirect, local/national or regional, etc. For each single characteristic a weight is estimated based on their importance to the society. The total value will than be used for computing the relative weights of different impacts. For example, let us assume that the development project has an impact on a rare, depletable, strategic resource and that the impact is of long term, irreversible and direct. Let us consider also that the weight for this combination of environmental resource characteristics is 4 and the weight of impact characteristics is also 4. The total weight will be 4 x 4 = 16. This figure will be compared with other impacts.

One solution is to first provide clear definitions for each criterion. Second, is to use a ratio. Here, it could be the number of people who benefit per dollar of investment (annualised capital and recurrent costs). Another option is to use population density in alternative project locations. Another suggestion for dealing with criteria that might be difficult to define and score is to focus on those criteria weighted most heavily by stakeholders. In the above example, local empowerment may be much weighted lower than environmental impacts. More effort should then be spent to define environmental impacts and establish a system for stakeholder appraisal[7]. Some criteria may be very difficult to work with if they cannot be clearly defined and tied to a scoring system. These might be better addressed through a qualitative decision-making system (see section f).

c) Decision-making with MAA

There are several methods for decision-making in an MAA framework. Perhaps the simplest to understand is aggregation[8]. This consists of summing up all the weighted scores of alternative projects. The preferable project will be the one that shows the best total weighted quality score. Box 8.10 provides an example of application of this technique with environmental criteria.

[7] Refer to Annex 4 for detailed information on how to deal with environmental impacts in MAA
[8] Refer to Annex 5 for detailed information on other methods of decision-making with MCA/MAA.

Box 8.10: Project Ranking Using Aggregation Technique

The table displays the weighted quality indicators of each single project impacts. This technique consists in summing up for each project the quality indicators and selecting the project that shows the highest score.

Weighted Valuation Matrix

Environmental Criteria	Alternative Projects			
	a	b	c	d
1	0.2168	0.2439	0.1626	0.1626
2	0.151	0.2114	0.1812	0.2114
3	0.129	0.1935	0.215	0.215
4	0.0856	0.0856	0.107	0.107
5	0.105	0.105	0.0735	0.063
Total	**0.6874**	**0.8394**	**0.7393**	**0.7590**

Ranking

a	4th
b	1st
c	3rd
d	2nd

Project b will be chosen

8.6.6 Decision-Making with Qualitative Criteria

As seen in the previous section, some criteria are difficult to fit into a quantitative framework. From the Swaziland example, criteria such as local empowerment, location and even environmental impacts might be problematic. Clearer specification of impacts would help but even then, a numerical assessment might be difficult. For these types of criteria, other options are required to make decisions within an MCA appraisal. Among the most widely used qualitative methods is frequency analysis.

With this method, a qualitative judgement of impacts (such as very positive fairly positive or insignificant) and of environmental goals (such as high priority or low priority) is required. On the basis of these values a matrix is built (Table 8.4).

Table 8.4: Impact matrix

GOALS						
Projects	1 *	2 **	3 *	4 **	5 **	6 *
A	x	xx	xx	xxx	xxx	xx
B	xx	xxx	xxx	xx	xx	x
C	x	xx	x	xxx	x	x

Where:

- A, B and C are the alternative projects;
- 1, 2, 3, 4, 5, 6 are the goals pursued by the projects (i.e., pollution reduction, create job opportunities, etc.);
- xx, xxx are qualitative judgements of impacts (i.e., xxx = very positive; xx = fairly positive; x = non significant); and
- **, * are qualitative judgements of environmental or other goals (i.e., ** = high priority; * = low priority) in a sense the weighting of criteria.

A frequency grid can now be obtained from the above matrix (Table 8.5). For example, from the impact matrix one can observe that very positive impacts of project *a* on high priority goals occur 2 times. Similarly very positive impacts of project *b* on high priority goals only occur once.

Table 8.5: Frequency matrix

Priority Level	** - high priority			* - low priority		
Impact Quality	xxx	xx	x	xxx	xx	x
Alternative Projects						
A	2	1	0	0	2	1
B	1	2	0	1	1	1
C	1	1	1	0	0	3

The next step consists in the identification of the best project by comparing the scores of the available alternatives. A further judgement is required here. Experts must decide upon a hierarchic order of the possible combinations of quality impacts and priority goals. For example, the hierarchic order is as follows:

(**, xxx) > (**, xx) > (*, xxx) = (**, x) > (*,x)

According to the above rule:

Comparison *a-b:* *a > b*
Comparison *a-c:* *a > c*
Comparison *b-c:* *b > c*

Therefore: *a > b > c*

8.7 UNCERTAINTY AND RISK IN PROJECT APPRAISAL

8.7.1 Background

The future is uncertain and this uncertainty lies at the centre of environmental policy issues. The analysis of risk and uncertainty for projects with environmental impacts are best handled by simulation and sensitivity analysis. We make the difference between risk and uncertainty by the possibility or not of assigning probability estimates to the production function, the environmental impacts and/or prices. For risk, it is possible to assign probabilities; for uncertainty it is not possible. Environmental impacts are more often uncertain. The impacts are difficult to foresee and even more to quantify. The uncertainty of projects is handled differently at the policy level which, needs to take more stakeholders including future generations into consideration. At the project level, a simple sensitivity analysis of the most crucial inputs, outputs and their prices may suffice to the decision-maker.

8.7.2 Sensitivity Analysis for Uncertainty (no probabilities)

Sensitivity analysis assesses how inputs, outputs and/or price (variables) changes effect the viability of the investment. For example, with a project to decrease soil erosion by planting trees, we want to identify how changes in predicted yield of the tree, price of the wood or project costs will in turn change the net benefits or IRR. The general approach is to systematically check the variables that strongly influence project viability. Switching values are often used. The switching value of a variable (say timber yields) is the value at which the project NPV changes from (+) to (-) or the IRR just becomes less than the discount rate. In practices, economists often define switching values as the value that makes the NPV equal to zero, and the IRR equal to the discount rate. Switching values are given in percentages. In other words, what percentage change (decline) in timber yields will make the project NPV zero (or negative), or the IRR equal to (or just below) the discount rate. The switching value can be useful in identifying variables that effect most project outcomes. They should be presented in order of importance and will have to be closely monitored by the project manager (Box 8.11).

Box 8.11: Switching Values in Sensitivity Analysis

Imagine an environmental drainage project aimed at decreasing a salinity problem with the following variables and switching values:

➢ Yield of tomatoes per hectare	- 20%
➢ Construction costs	45%
➢ Area drained/100m of canal	- 50%

The most critical value is the yield of tomatoes per hectare because it has the lowest switching value, followed by construction cost and area effectively drained per meter of canal constructed. A sensitivity test is most useful when the critical costs and benefits of the project are disaggregated in some detail so that the manager can follow them more closely. For certain type of projects, delays could be examined in the sensitivity analysis. A long delay in the drainage project could bring the salinity of the soil to a point where it is not economic to restore it.

Another approach for sensitivity analysis is to construct a matrix where critical project variables are changed up and down by various percentages, say 5%, 10%, 15% and 20%. The matrix links either the subsequent percentage change in NPV (or IRR) with each percentage change for the variables, or the revised NPV (or IRR). The analyst has to use professional judgement on what might be the probable range of percentage changes in the variables evaluated (Box 8.12).

Box 8.12: Sensitivity Analysis Matrix

	% Change in Variables and Revised Project IRR			
Variable	**-5%**	**-10%**	**+5%**	**+10%**
Yield of tomatoes	12%	8%	16%	18%
Construction costs	15%	18%	13%	10%
Area drained/100 m canal	14%	13%	14%	15%

In this case, the base IRR might be 14 percent and the hurdle rate 12 percent. Thus, the base case is economically viable because the IRR is greater than the hurdle rate. The sensitivity analysis derives a new IRR when each of the three variables is systematically changed by the percentages shown. The results show that the IRR is very sensitive to changes in the yield of tomatoes. A 5 percent decline in tomato yields changes the IRR from 14 percent to 12 percent, just equal to the hurdle rate. A 10 percent decline in tomato yields changes the IRR to 8 percent, well below the hurdle rate. By contrast, the IRR is relatively insensitive to changes in the area drained per 100m canal.

The limitation of the sensitivity analysis is that it does not say anything on the probabilities of occurrence of the events or their correlation. Since we have no information on the variability of the sensitive variables, the manager has to make decisions in a situation of uncertainty. Systematically varying one variable at a time *ceteris paribus*, i.e. holding the others constant at their expected values, is justified only if the variables are not correlated; otherwise they should vary jointly. In the example above the "yield per hectare" variable may be influenced by the area drained. A 10 percent decrease in the area drained may have a proportional impact on yield, which could lead to a much bigger decrease in NPV or IRR.

8.7.3 Sensitivity Analysis for Risk (probabilities can be determined)

When probability values can be assigned to some of the sensitive variables in the cash flow, the method used to simulate the risk of a certain NPV or IRR, is called "Monte-Carlo Simulation". While the expected probability of some variables are not often known, if key variable probabilities exist the expected value obtained will provide more information to the manager than "best estimates" used in the previous sensitivity analysis. Most managers will benefit from the extra information provided by the variance or standard deviation around the mean or the expected profitability index.

Usually the cash flows involve the product of two variables such as quantity (q) and price (p). In that case the expected value (E) of the product of two random variables is only equal to the product of the expected values if the two are statistically independent of each other. If they are correlated one needs to add the covariance between the variables.

Where *r* is the correlation coefficient and *S* the standard deviations. The magnitude of the error of not knowing or quantifying the correlation between the two variables will depend on the degree of correlation between the two. Environmental impacts on health and ecosystems have many correlated variables that are often not known. This increases the risk of the project appraisal. Experts can make judgements on estimates about variability and correlation until more research and experience allow better quantification of risky variables. If we don't have a clue about the probabilities and correlation of the environmental assessments or the cash flow variables, we are in a situation of uncertainty and the results of the sensitivity analysis can feed directly into the political debate.

Once the probability distribution of the most risky and sensitivity variables are assessed, a simulation would act as if implementing hundreds of the analysed investment. The result will be an average NPV or IRR with its probability distribution. Software exists to do that simulation. The degree of risk aversion of the manager, or for programs and policies, the elected decision-maker is important to interpret the results of the simulation.

8.8 RISK OF IRREVERSIBLE IMPACTS

Many project investments might have irreversible environmental impacts. An example might be to build a dam that will flood a unique habitat, high in biodiversity. The difference between the value someone places on having a good available and the expectation of the possible values other person will receive from consuming the good some point in the future has been named "option value" (Weisbrod 1964). From an efficiency viewpoint, decisions concerning irreversible development involve comparisons between the cash flows coming from development and from the expected net benefits of preserving the environment. Investment in development should be halted if the returns from development are decreasing relative to the returns associated with preservation (see Box 8.13).

Box 8.13: Taming A Wild River: The Case Of Hell's Canyon

The Snake River passes through a 200-mile stretch of the border between Oregon and Idaho known as Hell's Canyon. It is one of the most scenic rivers in the United States, described in a letter dated November 8, 1968, by then U.S. Secretary of Agriculture Orville Freeman as: *an awesome stream consisting of a series of swift white-water rapids flowing into deep pools in one of the deepest Canyons in the United States. . . . There is no doubt that this stretch of the Snake River represents one of the last of this country's great rivers*.

Hell's Canyon was also an attractive site to build hydroelectric dams for the same reasons. Development was considered as far back as the 1940s by the U.S. Army Corps of Engineers, as part of its overall development plan for the Columbia River System. In the late 1950s, the Federal Power Commission (FPC), which was the precursor to the Federal Energy Regulatory Commission (FERC), licensed three sites in the upper reach of Hell's Canyon for development. In 1964, the FPC granted a license to the Pacific Northwest Power Corporation to develop the lower reach of Hell's Canyon. That development would have eliminated forever the whitewater rapids that Secretary Freeman wrote so eloquently about.

The secretary of the interior challenged the FPC decision, and in 1967, the U.S. Supreme Court ruled that the FPC had not considered other benefits of the area that would be lost forever should development occur, including the loss of salmon species. The Court ordered the FPC to reconsider the license application. In 1969, economists John Krutilla and Anthony Fisher undertook to measure the environmental costs associated with development, submitting a "friend of the commission" study. They were able to measure some of these environmental costs, including the potential loss of recreation opportunities, but they noted that other costs, such as the extinction of salmon species, were impossible to measure.

Krutilla and Fisher quantified and incorporated into their benefit-cost analysis the environmental opportunity costs associated with hydroelectric development. They estimated measurable preservation benefits and primarily recreation benefits and then determined how large those benefits would have to be in order for the *total* preservation benefits to equal the benefits of development. They found that annual preservation benefits would have to be at least $80,000 in order to equal annual development benefits. However, their study found that the quantifiable benefits alone from preservation were almost $900,000 annually, far exceeding the annual benefits from development. Ultimately, Congress prohibited further development of Hell's Canyon.

Source: Krutilla and Fisher (1975).

8.9 THE PRECAUTIONARY PRINCIPLE

Given the uncertainty context of irreversible decision, the focus should be on the value of information that may be gained by delaying development. Many development decisions have uncertain environmental benefits and potentially irreversible environmental costs. The precautionary principle (PP) is based on the concept above. In case of uncertainty to develop an area or to set pollution standards, lack of full information should help postpone decisions that are not crucial or urgent. Some immediate development benefits can be foregone but this may be for greater environmental benefits into the future. Since the unique environment will become rarer with time, it is safe to assume that their values may increase relative to other goods and services. A practical framework to follow is the "Safe-Minimum-Standard" (SMS) and "minimax" approach. The SMS approach has theoretical roots in game theory. Under the minimax principle, society should choose the strategy or policy that minimises maximum possible losses.

The game can be presented in matrix form:

Strategies	***State 1***	***State 2***	**Maximum Losses**
Development	0	B_c	B_c
Conservation	B_d	B_d - B_c	B_d

In state one, it is assumed that the implementation of a development project in the area does not preclude any benefits into the future because the gene pool will not be used or could be available elsewhere. In state two, one species preserved happens to become worth a lot for breeding a special type of tree for animal food production. Let this amount be the benefit of conservation B_c. If the base point of the pay-off matrix corresponds to the development strategy in state one, this value is zero. In state two, for the same strategy, the value of the social loss incurred would be B_c. The highest of these two values, B_c, represents the maximum possible loss for the development strategy.

In the case of preserving the area and assuming a state corresponding to no use of the gene pool in the future, the cost involved, as mentioned previously, is the net benefit of the best development project foregone or B_d that is assumed to be known with certainty. However, B_d

does not include the possible value of the species preserved that permits the development of animal food production, B_c. If conservation is chosen, a loss of B_d will be incurred in state one and, in state two, the social loss will be $B_d - B_c$. The higher of these two values, B_d, is the maximum possible loss for the conservation alternative. The minimax principle indicated that the development strategy should be adopted if $B_d > B_c$. The conservation option (SMS) should be chosen if $B_c > B_d$. One would be indifferent between the two strategies if B_d approaches B_c.

This criterion poses several problems. First, the uncertainty surrounding the decision is still present. Effectively we do not know the probabilities attached to alternative outcomes. Secondly, the outcomes themselves are assumed to be known with accuracy. This is a strong assumption, especially concerning B_c. Thirdly, the beneficiaries of development are members of future generations and the compensation they would ask for is not known, so again the value of B_c should be considered as a minimum. The criterion may be biased towards development in the case where these unquantifiable benefits are not taken informally into consideration. If some value index in addition to the valuation technique could be worked out for the non-measurable benefits, these benefits could be taken into consideration in the decision-making process by using multi-objective techniques such as MCA and MAA.

8.10 ADDRESSING THE DISTRIBUTION OF COSTS AND BENEFITS

8.10.1 Background

A typical cost-benefit analysis focuses on economic efficiency. The two main steps are a financial analysis and then a broader economic analysis. A third step, often overlooked, is a social analysis to consider the distribution of costs and benefits within society. The implicit assumption in general cost-benefit analysis is that each additional dollar of income is equally important to each individual in society, regardless of who receives it. The reality of most projects is that some groups in society gain some measure of benefits, while other groups either receive a smaller share of benefits or absorb a higher proportion of costs (or both). The distribution of costs and benefits of a project among beneficiaries, government, and specific stakeholders will significantly affect its acceptability. Non-economic considerations and particularly, those associated with the distribution of costs and benefits have an important influence in determining the political pressures which, may emerge in favour or against the project.

8.10.2 Approaches for Distributional Analysis

A simple approach for evaluating the distribution of costs and benefits is to first identify the main groups affected by the project. In large projects, this may be the investor (private company, development bank, etc.), government, and local people where the project is planned. The next step is to allocate incremental project income (measure of benefits) and project costs (measure of costs) among the main groups affected by the project. As an example, a review of the financial analysis might suggest that the private investor receives 60 percent of total incremental income, government 30 percent and local people only 10 percent. Extending this further, it may be found that of the income accruing to the investor, half will flow offshore to foreign shareholders. Whether these situations are equitable or not requires qualitative judgements, particularly in comparison to the incidence of costs. The project may be totally funded by the private investor, yet government may have to invest in social and infrastructure costs (extra schools, clinics, etc). Local people may bear environmental costs.

This very rough comparison brings the concept of compensation into the equation. Will the groups in society gaining from the project compensate those groups bearing an inordinate share of tangible and intangible share of costs? In theory, a pareto improvement in social welfare should be sought, where some people are made better off by the project without making others worse off. If the "losers" from the project could be compensated by the "winners" (through direct payment, tax redistribution, etc), then distributional issues can be addressed. In practice however, direct compensation is rarely paid and the tax system is very cumbersome in redistributing income among groups in society.

A more complex system to deal with distributional analysis involves assigning weights to different groups in society in relation to costs and benefits. From the previous example, repatriated private income might receive a weight of zero because it flows out of the country. Income flowing to local villagers might receive a higher weight. Costs incident on local people might receive a higher weight because of the lower ability to pay, or absorb the costs/impacts. Developing a distributive weighting system is very difficult in practice because of the element of subjectivity. Another problem is that the costs and benefits must be traced to the income group of the final recipients. Distinguishing between intermediate and final recipients is difficult. Also, the cost of living and hence relative net income levels of people will vary by location. One method that has been used in practice is to look at marginal tax rates across income groups. A group with a 15 percent marginal tax rate (implying lower incomes) could have project benefits weighted twice that of a group with a 30 percent marginal tax rate (Pearce and Nash 1991). The problem however, is that in developing countries, many people, especially in rural areas, do not pay income tax.

Deriving an effective and practical weighting system remains a problem. Avoiding the issue implies a value judgement that the existing distribution of income is optimal. Obviously, this is not likely the case, however the analyst has little global experience to build on. Often the best that can be done is to identify the key groups affected by the project and present a summary of how major measured costs and benefits are distributed. Then, decision-makers can use the information in judging the overall merits of the project.

8.11 PARTICIPATION IN PROJECT APPRAISAL

8.11.1 Background and Definitions

Participation is *a process through which stakeholders influence and share control over development initiatives, and the decisions and resources which affect them*[9]. *Stakeholders* are all of the individuals or groups that are directly or indirectly affected by the project including those that are inadvertently or negatively affected it. *Beneficiaries,* one type of stakeholder, are the target group of the project. They are the individuals that are, intentionally, directly affected by the output of a project, such as those who receive access to water from an irrigation project. The range of stakeholders for an irrigation project, for example, would include:

- Beneficiaries;
- Individuals displaced by construction of the reservoir that supplies water irrigation;
- Downstream communities whose water has been diverted by the project;

[9] Bank's Learning Group on Participatory Development.

- NGO's engaged in training;
- Government agencies involved in the project; and
- Agencies providing project financing.

Participation Enables Stakeholders To Influence And Share Control Over Decisions

Participation is an approach to development based on collaboration. The value of collaboration is that it increases the range of people who are committed to the success and sustainability of interventions. Participation in a project context means collaboration from the earliest stages of planning through decision making, implementation, monitoring and evaluation. Collaboration can range from the sharing of information to sharing of decision-making power. In projects where collaboration is more intense, stakeholder involvement spans the range. Such projects are said to be highly participatory. For example, an irrigation project, which is highly participatory, might include stakeholders in the following decisions (among others):

- Stakeholders are invited to a workshop to discuss alternatives for site selection and technology choices;
- Stakeholders work with financial analysts to determine beneficiaries' willingness to pay for services and appropriate methods of payment; and
- Stakeholders identify and strategize about how to include vulnerable or marginal groups, in decision making; stakeholders identify and evaluate the capacity of institutions to support the delivery of project services; stakeholders help to identify indicators for project monitoring and training to undertake the monitoring.

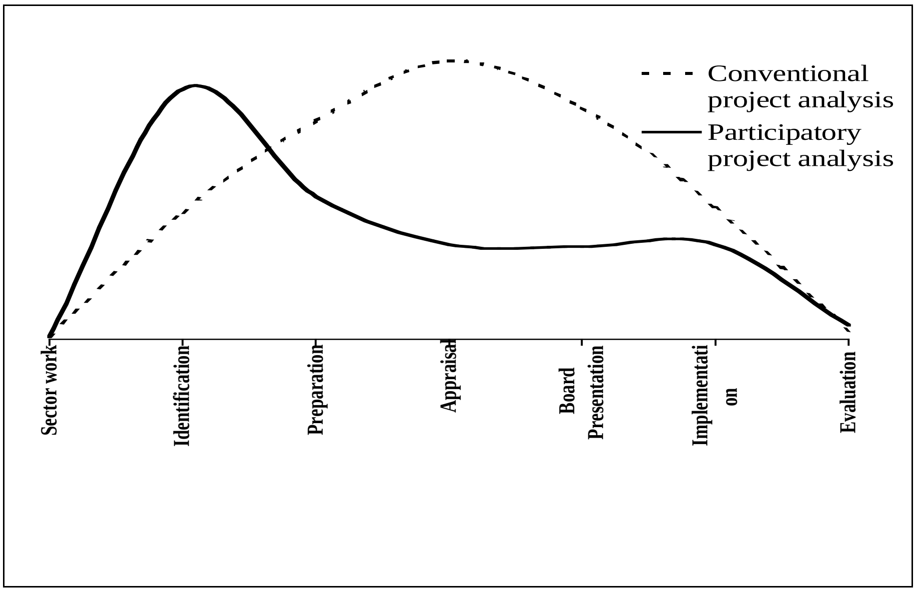
Stakeholder Participation Enhances Commitment to Project Sustainability

When stakeholders are involved in projects from the outset, they are more likely to understand the costs and benefits that have been weighed in decision-making, and they are therefore more likely to be confident that the decisions made are the "best" solutions. Such confidence contributes to resolution among stakeholders to work throughout the life of a project toward its success. Participation also minimises risk by improving the quality of the information that goes in to the decisions being made.

8.11.2 Participation and the Project Cycle

The irrigation example above highlights the iterative nature of participation; it is a process that takes place over and over again, throughout the project cycle. Stakeholder attitudes towards a project are critical to project success, starting from identification and appraisal and going through to implementation and evaluation. However, participation is particularly important during the early stages of project formulation and analysis, when identifying and designing a project is the principal objective. The resources allocated for participation should be focused on the identification and feasibility stages of the project cycle rather than the appraisal stage, which is the norm in project analysis (Figure 8.4).

Figure 8.4: Participation and the project cycle



8.11.3 Participation and Project Analysis

Participation and project analysis is a natural marriage. Both are processes for gathering information and making decisions. Project analysis serves a discrete function. The information gathered and analysed helps decision-makers to identify the 'best' project from among a series of alternatives. In that context, participation is simply an approach to project analysis which enhances the quality of information, improves the outcome of analysis, and minimises risks by improving the chances of project design which addresses stakeholder needs. The project analyst can begin to adopt a participatory stance by systematically listening to and consulting with stakeholders, and then including this information in the analysis.

8.11.4 Pointers for Participation

a) Using the methods well

It would be misleading to assume that certain tools and methods are inherently participatory, spontaneously encouraging ownership and innovation among stakeholders. The participants in development planning and action -- the users of these methods and tools -- must encourage and enable participation. The tools themselves facilitate learning, preparation, and creative application of knowledge. They make it easier for collaboration among a broad range of stakeholders in the selection, design and implementation of development projects. The methods can also be implemented in a top down manner that merely pays lip service to participation. The responsibility of using these methods well rests with the entire range of stakeholders.

b) Practice pointers

Following are ten practice pointers, which apply to the overall process of participation. More in-depth information on these and other pointers can be found in the *World Bank Participation Sourcebook.*

- Start the participatory process as early as possible;
- Ensure government support for the participatory approach;
- Identify stakeholders;
- Involve stakeholders;
- Learn from the poor;
- Facilitate women’s participation;
- Build community capacity;
- Involve intermediary NGO’s;
- Involve responsive government institutions; and
- Consider legal and regulatory measures which support participation.

8.12 PRICE CONTINGENCIES

A practical issue in project planning is dealing with price contingencies over time. We have already learned that the best approach for dealing with costs and benefits is to assume constant prices over time and use a real discount rate in the appraisal. This is a valid approach when working with one currency. As an example, a project in the UK would be evaluated in terms of constant UK prices and inflation would be tackled with a real discount rate. The situation in developing countries however, is that many projects are financed with external resources, say a project in Zambia with US$. If the recipient country has high domestic inflation, then the challenge is to design the project to allow sufficient local dollars to cover price changes over time. Financial resources often need to be added to base costs to cover local inflation. In any project, all the annual expenditures will not occur at the beginning, or at the end of the year. Instead, cash flows tend to occur throughout the year. Economists tend to use the middle-of-the-year (MOY) accounting practice. That is, we assume that expenditures occur half-way through each financial year.

The short cut formula to calculate the price contingency in any year is (Ward and Deren 1995):

$PC = [(1 + i)^{n-0.5}] - 1$ where,

PC = conversion factor applied to base costs for that year
i = annual average inflation rate
n = year of project

As an example, if inflation is 12 percent, the calculation for year 1 becomes:

$$PC = [(1 + .12)^{1-0.5}] - 1 = [(1.12)^{0.5}]-1$$
$$= 0.058 \text{ or } 5.8\%$$

If base costs are $100,000 in year 1, then an additional $5,800 is required to cover local inflation. This example is very simple. Complications arise when the local currency (where the project is sited) may be depreciated over the course of the project because of high inflation. When the local currency depreciates by say, 20 percent relative to US$ and you hold project funds in US$, you will “gain” an additional 20 percent when the US$ are converted to local currency over the course of a year. The actual gain however, is contingent upon the rate of local inflation. If currency depreciation equals the local inflation rate then the price contingency is zero. As you convert US$ into local currency, you will match local inflation.

Unfortunately, the world is not perfect. Currency markets may not be completely liberalised. A situation could exist where the local currency depreciation over the life of the project was expected to be an average of 20 percent per year. Local inflation was forecast to be an average of 30 percent. In this case, an average price contingency of 10 percent could be used in the previous formula. If the predictions of price and currency changes held, the project would be assured of enough local dollars to keep up with inflation after accounting for any currency depreciation.

A worse case is Zimbabwe where inflation in 1999 peaked at around 70 percent, yet the local dollar was “informally” managed[10] with no depreciation from March of that year. In fact in June, banking authorities, under government pressure actually strengthened the rate, against all economic reality. In these situations, planning for price contingencies is difficult. One requires a good crystal ball to guess at future price changes relative to probable currency depreciation in a highly charged political environment.

8.13 COMPUTER APPLICATIONS IN PROJECT APPRAISAL

8.13.1 NPV and IRR Calculations

As mentioned earlier in this module, most spreadsheet packages have internal financial functions including PV, FV, NPV and IRR. Many economists use Excel and the functions are described here. With PV and FV, these functions derive annuities; they assume equal cash

[10] Following severe depreciation of the local dollar in 1998 and early 1999, the Zimbabwe Reserve Bank ordered commercial banks to “manage” the dollar within certain limits, otherwise official currency controls would be imposed. The outcomes of such a policy decision were predictable; shortages of foreign currency for importers, and major exporters being increasingly unable to compete in global markets as their local costs increased by 50-60 percent without any compensation in the form of a depreciated currency. A good example of market distortions caused by government intervention.

flows each year. The cash flow can be set to occur at either the beginning or end of the year. To calculate the PV of irregular cash flows, the NPV function can be used but it assumes cash flows occur at the end of the year. IRR operates on the same basis. These functions allow quick calculation of NPV and IRR for complex projects. The challenge is to set up the with-without framework on your spreadsheet to end up with a final column showing incremental net income (or benefits). Then the NPV and/or IRR functions can be applied to this column only.

8.13.2 Multi-Criteria Analysis

This technique is receiving considerable academic attention and as such, models are being developed to derive some of the decision-making matrices. Two examples are the ELECTRE (Elimination Et Choix Traduisant la rEalite) from France and NIMBUS from Scandinavia. The NIMBUS model is available on the internet.

8.13.3 Project Costs

Many development banks and investment agencies (such as the FAO) use a PC-based package called PC-COSTAB to deal with project costs. The software handles price contingencies, inflation rates (for both local and external expenditures), taxes, capital and recurrent costs. It also can produce summary tables showing the breakdown between costs funded through foreign exchange (imports such as vehicles or computers) and local expenditures. Tables can also be built to show taxes paid in-country, a feature often desired by government.

8.14 SUMMARY

Financial resources are limited relative to demands from all corners of society. Consequently, good decisions are required about allocating resources for investments in development projects. An appraisal of economic viability is part of the project cycle and can be done using several approaches. With a traditional quantitative appraisal, a financial (from a narrow private or personal perspective) and economic (viewed from society as a whole) analyses are normally carried out. Where prices are distorted from policy and market failure in the economy, adjustments may need to be made using various “shadow pricing” techniques.

The most common appraisal method based on efficiency criteria is net present value under a general cost-benefit analysis (CBA) framework. Decision-making is often aided by using internal rate of return (IRR) and/or benefit-cost ratio (BCR). The methods can be used to appraise individual projects, or to prioritise the most efficient projects under budget constraints. These methods require discounted cash-flows to be used. One method not using discounted cash flows is the minimum payback period. Other analytical methods are based on costs, include cost-effectiveness analysis, and break-even analysis. These latter methods tend to be used after the decision has been made to proceed with a project when help is needed to select the least-cost approach.

In many projects where environmental impacts exist, or where appraisal requires a broader set of objectives to be evaluated, multi-criteria analysis (MCA) can be used. Due to its flexibility and manageability, MCA has a broad applicability to policy and project analysis for decision-making. However some limitations of this method should also be kept in mind. The first limitation is that of deciding whose preferences should be taken into account since different groups (social, experts, etc.) will assign a different priority to the diverse objectives. In addition, the priority assigned to the various impacts or criteria can be interpreted as a monetisation of the costs and benefits of a project, which leads to the same criticisms raised against CBA approach when attempting to place a monetary value on intangibles. Another criticism is that MCA requires as much information than CBA.

Regardless of the methods used, project appraisal should consider risk and uncertainty. Risk assumes probabilities can be assigned to factors affecting the outcome of the project such as prices, costs, environmental impacts, etc. Uncertainty implies that no probabilities can be assigned. The usual case in project appraisal is to accept conditions of uncertainty and use a sensitivity analysis to evaluate to what degree certain factors must change to significantly affect the viability of the investment. The issue of irreversible impacts must also be taken into account. The concept of safe minimum standards is useful. One often-overlooked area in project appraisal is equity, or the distribution of costs and benefits among different groups in society. In theory, weights should be assigned to costs and benefits to reflect criteria such as average income. In practice, deriving weights is a controversial issue and is usually not done. A second best solution is to at least identify what groups are affected by the project and indicate the share of benefits and costs incident on each group.

Participation is *a process through which stakeholders influence and share control over development initiatives, and the decisions and resources which affect them*. It is important in project analysis because it enhances the quality of project design and improves the outcome of the analysis. Participation also minimises risk by improving the quality of the information that goes into the decisions being made. Participation is a conceptual stance that starts with the project analyst's willingness to listen and consult, and ends with the stakeholders sharing control of all phases of the project. Participation should be emphasised early in the project cycle, at the project identification and selection stage.

In countries where inflation is high relative to trading partners, it is important to ensure that the project will disburse sufficient funds to meet local costs. Where funds are externally sourced, the difference between local inflation and depreciation of local currency is important to consider. Methods are available to derive price contingencies that account for these factors.

At present, the numerical aspects of project appraisal is relatively easy with computer software such as spreadsheets and more sophisticated models, for example for MCA. While these tools allow faster calculations of measure such as NPV and IRR, and permit rapid assessment of sensitivity analysis, the need to use accurate information remains a critical point.

ANNEXURE 1: Hypothetical Examples of Shadow Pricing

1. Import Parity Price of Maize (for project in Central area of Mozambique)

Shadow Price Variable	US$/Tonne
Import price of rice from Johannesburg, South Africa:	127
Bagging and loading in Durban	15
Freight, insurance and customs Durban to Maputo	30
Total CIF (Customs, Insurance and Freight) at Maputo	172
Unloading and storage in Maputo	3
Total in-store price in Maputo	175
Less transport and bagging to project area (200 km away)	25
Expected economic farm gate price at project area in US$	**150**

Expected **economic** farm gate price at project area (local currency)	1900
Actual **financial** farm gate price at project area (local currency)	1800
Conversion factor (actual/adjusted price)	**0.95**

2. Export Parity Price for Sugar, (for project in Central area of Mozambique)

Shadow Price Variable	US$/Tonne
World price of sugar exported FOB from Beira	264
Less transport costs from mill to docks	12

Net value per tonne of sugar at mill	252
Net value of cane at mill (10 % of sugar price)	25.2
Less cane processing costs at mill	7
Less transport costs from project area	3
Delivered mill economic price for cane at project area in US$	**15.2**

Expected **economic** price of cane at project area (local currency)	220
Actual **financial** price of cane in project area (local currency)	200
Conversion factor (220/200)	**1.10**

ANNEXURE 2: Discounting Cash Flows

1. Compounding and Discounting

Compounding is the term we use when we calculate the **future value** of a deposit or investment at a given interest rate (discount rate). The formula is:

$$\mathbf{FV = PV \times (1+i)^n}$$

Where FV = Future value of a deposit or investment
PV = Present value of our deposit or investment
i = Annual interest rate (discount rate)
n = Time period

Example: $1000 deposit @ 14% interest rate for one year

$FV = \$1000 \times (1 + 0.14)^1 = \$1140.0$ at the end of 1 year

If we consider two years, then the formula becomes:

$FV = \$1000 \times (1 + 0.14)^2 = \$1299.6$ at the end of 2 years

Discounting is the reverse of compounding where we are now calculating the **present value** of sums received in the future. The formula is:

$$PV = \frac{FV}{(1+i)^n}$$

Where PV = Present value of a sum received in the future
FV = Future value or sum we will receive later
i = Annual interest rate (discount rate)
n = Time period

Examples: PV of $1000 to be received at the end of one year (14% discount rate)

$$PV = \frac{\$1000}{(1 + 0.14)^1} = \frac{\$1000}{(1.14)} = \$877.19, \text{ rounded to } \$877$$

PV of $1000 received at the end of two years at discount rate of 14%

$$PV = \frac{\$1000}{(1 + 0.14)^2} = \frac{\$1000}{(1.2996)} = \$769.48, \text{ rounded to } \$769$$

Compounding and discounting are similar processes except for the direction of your calculation. Compounding gives us future values of cash flows while discounting brings future cash flows back to the present.

COMPOUNDING

------------------------------->>

Present Value **Future Value**

<<-------------------------------

DISCOUNTING

You can derive compound or discount factors for any interest rate and time period quite easily if your hand calculator can handle exponents, for example $(x)^n$. A computer spreadsheet programme like Excel can derive present and future values once the cash flows are set up in columns. If all else fails, refer to tables A-1 (discounting) and A-2 (compounding) at the end of this annexure. The factors in the tables use cash flows occurring at the end of the year. Simply select the interest rate (on the top row) and the number of years either to receive a payment (discounting) or wait for a payment in the future (compounding). The cross-referenced cell has a factor (compounding or discounting) that is multiplied to the payment to give either the FV or PV [11].

2. Effect of Changing the Discount Rate

The higher the discount rate, the more severe will be the effect of discounting future costs and benefits to the present. Conversely, a high discount rate will make the future value of current costs and benefits larger. As an example:

Present value of $50,000 received at the end of five years from now:
@ 5% = $39,176
@ 25% = $16,384
@ 40% = $9,297

Future value of $50,000 invested for five years:
@ 5% = $63,814
@ 25% = $152,588
@ 40% = $268,912

3. Effect of Time on Project Viability

The longer the time period, the more pronounced will be the effect of discounting and compounding, regardless of the interest rate used. As an example:

Present value of $50,000 at discount rate of 10% received:
after 5 years = $31,046

[11] A computational note: the discount factors in Table A-1 represent the inverse of the factor derived using the formula to calculate discount factors. This saves a step when using calculators. Instead of having to divide

after 25 years = $4,618

after 50 years = $426

Future value of $50,000 invested now at 10%:

over 5 years = $80,526

over 25 years = $541,735

over 50 years = $5,869,543

For long-term projects such as forestry plantations of indigenous trees, the present value of future timber benefits will often be quite low. If a project has a long time horizon and, a high discount rate is also used, the present value of future benefits will be negligible and usually less than the original investment costs. While you cannot do much about the time period of some projects, you have options for selecting your discount rate.

4. Annuities

Annuities are equal cash flows that occur every year. In projects, annuities could take the form of annual maintenance costs that remain constant in real terms. Computer spreadsheet programmes can easily calculate annuities. Otherwise, tables are available to calculate both the present and future value of annuities by hand. Refer to Tables A-3 and A-4 at the end of this Annex for annuity factors (both PV and FV). Simply multiply the annual payment by the annuity factor to get either the PV or FV values of the equivalent cash flows.

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the future cash flow by the discount factor, the inverse discount factors mean you can just multiply the cash flow and get the PV.