8. ECONOMIC AND FINANCIAL ASSESSMENT

Key concepts and words:

Project viability; Economic and financial viability; Methods of financial and economic analysis; Discounted cash flow; Discount Rates; Cost benefit analysis; Sensitivity Analysis; Cost-effectiveness analysis; Economic analysis.

INTRODUCTION

Viability for a project refers to the assessment of whether the project has the capacity to meet the defined objectives, and in addition to generate significant financial and economic gains to the stakeholders and to the economy in general. Financial and economic viability are not the overriding criteria for approval of all projects. There may be projects which appear to have very high potential for economic gain but which are very risky in terms of the technical, social and institutional factors; or have negative impacts on the environment. There may be other projects where social and environmental factors are very strong but all the economic gains cannot be easily estimated or valued. This chapter discusses the economic and financial assessment of projects, while Chapter 9 focuses on the environmental assessment of projects. Issues of social and institutional viability of projects were also dealt with under sections in Chapter 7 on project design and analysis.

PROJECT VIABILITY

Project viability depends on a number of factors in addition to economic ones, and the decision to go ahead with a project or not will depend on multiple criteria. But when investment funds and resources are limited, project sponsors tend to try to ensure that funds are used to enhance economic development by generating additional resources for the economy. More significantly, the appraisal of project viability must seek to identify cases where investments of scarce resources are likely to lead to actual net losses, and avoid or change these projects. In designing a project, planners must have established the social, institutional, environmental and technical base for viability. These must also be the base for financial and economic viability. The selection or rejection of a proposed project should be made on a number of different criteria, of which economic and financial viability will be necessary but not always a sufficient conditions - see multi-criteria analysis in Chapter 12. This Chapter however focuses on the financial and economic viability of projects. These and other common terms used with financial and economic assessment are defined in Box 8.1.

Box 8.1 Definitions of key terms

Benefit Cost Ratio (BCR) - is the ratio of total discounted benefits to total discounted costs. A BCR greater than one indicates a viable project.

Cost Benefit Analysis (CBA) - is the general term which is used to analyse to present and future costs and benefits of a project. This involves the use of discounted cash flows.

Cost-Effectiveness Analysis (CEA) - where benefits cannot be properly valued in monetary terms CEA is used to answer the question: Which project alternative can produce a set level of benefits for the cheapest cost ?

Discount Rate - To allow for the changes in the time value of money, the terms "present value" and "future value" are used. To calculate the present value of future costs and benefits their future values are "discounted" back to the present using a discount rate.

Economic Analysis - The principal objective of the economic analysis of projects is to assess the efficiency with which resources are used. Thus, for the ex-ante appraisal of a particular project, the concerns are much related to assessing the extent to which the same objectives might be achieved using fewer resources, or whether the same resources might be used to achieve a greater range of objectives.

Economic viability: the capacity of a project for an overall gain to the economy in terms of significant net additional benefits generated and efficient use of resources.

Financial viability: the capacity of the project to generate sustainable financial returns for the various stakeholders.

Internal Rate Of Return (IRR) - is defined as the discount rate at which the NPV is zero. It is the rate at which the project's benefits are equal to the costs, and reflects the rate at which the project investment is just recovered.

Net Present Value (NPV) - is the net sum of total discounted benefits and total discounted costs. This yields a figure showing the excess (or shortfall) of benefits over costs in monetary terms. Generally if the NPV is positive after using a suitable discount rate then the project would be recommended as viable.

Opportunity Cost - the value to the economy of goods, services or resources "lost" in the development of an alternative project intervention.

Resource And Cash Flow Statements - are the basis for showing: the resources used in the project investment; the resources generated by that investment; the cash flows associated with those resource flows; and, the cash flows associated with funding the investment.

FINANCIAL AND ECONOMIC ANALYSIS

Distinction between financial and economic analysis

The differences in the definitions of economic and financial viability are reflected in the differences of financial and economic analysis. While some of the actual tools of analysis are the same, financial analysis is concerned with private profitability and is based on financial flows which relate to:

- market prices for products and inputs
- the terms of credit and borrowing in general
- tax and subsidy policy
- financial depreciation and other financial conventions

Economic viability is concerned with public "profitability" which is based on economic resource flows which relate to:

- Social opportunity costs (shadow prices) which adjust market prices to take into account differences based on:

  - taxes and subsides
    external costs and benefits
  - monopolistic pricing
  - price control and rationing
  - quantitative trade restrictions
  - over-valued (or under-valued) exchange rate
  - labour opportunity costs

- Divergence between real rate of interest and nominal (financial) rate of interest, and difference between private and social/public rate of discount.

The issues of economic analysis are described at the end of this Chapter.

Methods of economic and financial analysis

To assess economic and financial viability a range of tools and methods can be used, Box 8.2. These are reviewed in this Chapter. Financial and economic analysis are concerns of those undertaking a project, while society's concerns are mainly with the opportunity cost of diverting resources to the project, i.e. macro orientated efficiency in resource allocation.

Box 8.2 Methods of economic and financial analysis

- Resource Flow Statements
- Cash flow Statements
- Discounted Cash Flow
- Cost Benefit Analysis
  - Net Present Value
  - Internal Rate of Return
  - Benefit-Cost Ratio
- Cost Effectiveness Analysis
- Sensitivity Analysis

RESOURCE AND CASH FLOW STATEMENTS

Resource and Cash Flow Statements are the basis for showing:

- the resources used in the project investment
- the resources generated by that investment
- the cash flows associated with those resource flows
- the cash flows associated with funding the investment

The basic format for all these statements in a revenue project is shown in Table 8.1. There is usually an "investment period" during which income may be nil or lower than costs, followed by a "revenue period" when incomes exceed costs and the investment is earning its return. A year is the standard unit and it is usually used as an account period in all financial analysis. Detailed cash flows used in project implementation may require monthly units. The net cash flow is shown on one line with negative and positive values.

Table 8.1 Format for Resource/Cash Flow Statements

	Year 0	Year 1	Year 2	Year 3	Year 4
Income *(Resources Generated)*		2,000	6,000	8,000	12,000
Investment Costs *(Resources Used)*	8,000				
Operating Costs *(Resources Used)*		3,000	5,000	6,000	7,000
Net Cash Flow	-8,000	-1,000	+1,000	+2,000	+5,000

In the example in Table 8.1 the cash flow is negative for year 0 and becomes more positive for years 1 to 4. This is a common feature of many agricultural projects. In early years they are characterised by heavy investment with little or no output.

An example of resource flow statement for a simple hypothetical agricultural project is given in Table 8.2. This project involves activities such as farmer training, extension and research, assistance to small traders, and credit. The expected effects of the project are to promote improved farm management and better use of inputs to increase farm production, this will be through incremental change to existing production. The project will also assist small traders with storage and transport facilities.

Table 8.2 Resource flow statement for a hypothetical agricultural project

Description	*Unit*	*Unit price*	*Year* 0	1	2	3	4	5 to 19
INCREMENTAL FARM OUTPUT								
Coffee production	**mt**				**125**	**150**	**230**	**230**
Maize production	**mt**				**320**	**360**	**390**	**390**
Coffee	$	1200			150,000	180,000	276,000	276,000
Maize	$	100			32,000	36,000	39,000	39,000
INCREMENTAL FARM REVENUE	$				182,000	216,000	315,000	315,000
INCREMENTAL FARM INPUTS								
Labour - hired	**days**			**5,000**	**7,500**	**11,000**	**13,000**	**13,000**
Labour - family (non-expense)	**days**			**12,000**	**15,000**	**18,000**	**18,000**	**18,000**
Fertiliser	**bags**			**2,000**	**3,000**	**4,000**	**4,000**	**4,000**
Hired labour	$	3		15,000	22,500	33,000	39,000	39,000
Fertiliser	$	25		50,000	75,000	100,000	100,000	100,000
Tools and Equipment	**$**			**45,000**	**9,000**	**9,000**	**9,000**	**9,000**
INCREMENTAL FARM COSTS	$			110,000	106,500	142,000	148,000	148,000
NET FARM CASH FLOW	$			-110,000	75,500	74,000	167,000	167,000
INCREMENTAL MARKETING	$							
Trading Revenue (Value Added)	**$**				**63,700**	**75,600**	**110,250**	**110,250**
Transport, Storage, Admin.	**$**			**50,000**	**36,400**	**43,200**	**63,000**	**63,000**
NET MARKETING CASH FLOW	$				27,300	32,400	47,250	47,250
NET PROJECT BENEFITS			0	-160,000	102,800	106,400	214,250	214,250
PROJECT COSTS								
Staff	**months**		**36**	**36**	**36**	**36**	**24**	**0**
Staff Costs	$	1500	54,000	54,000	54,000	54,000	36,000	0
Buildings and Equipment	**$**		**100,000**	**50,000**	**0**	**0**	**0**	**0**
Operating Costs	**$**		**65,000**	**90,000**	**90,000**	**60,000**	**30,000**	**0**
TOTAL PROJECT COSTS	$		219,000	194,000	144,000	114,000	66,000	0
NET FINANCIAL FLOW	$		-219,000	-354,000	-41,200	-7,600	148,250	214,250

Notes:

1. Figures in bold represent resource flows, while figures in italics represent cash flows.
2. Assumes project activities finish after end of year 4.
3. No cash flow is assumed for family labour as cash stays within household.
4. Trading revenue is assumed to 35% of farm revenue; and, transport and storage etc. 20% of farm revenue.

The costs and benefits are shown for the first 5 years (Years 0-4) and then the last column shows Years 5-19, on the large assumption that the gains will be sustained after the project activities cease in Year 4. Where possible, physical quantities are used for resources, and then their prices are used to give the associated cash flow value. In some cases only the summary value of resources such as tools and equipment may be shown. In Table 8.2 resource flows are shown in bold type, and cash flows in italics.

This resource flow statement separates the resource flows of the three parties: the farmers, the traders and the project. The traders generate "resources" by adding value to the commodities they trade. The farmers and traders have their own investment and revenue periods, that is, they are required to use resources before they earn income from generating new resources. Later financial cash flows will be devised for the funding of these initial investments through credit and other funds. Credit is not shown in the resource flow as it is purely a financial transfer, no physical resources are involved.

The annual net cash flows of farmers and traders together represent the annual "net project benefits". These may be negative during their investment periods. The combination of annual net benefits and annual project costs yields the bottom line of "net financial benefits", that is, the net value of resources used and generated at market prices. The overall worth of the project will be assessed by analysis of the net financial benefits, using discounted cash flows and cost benefit analysis.

In this example, financial analysis examines the net cash flows of the farmers and traders to find viable funding solutions. Although it can be seen that if the farmers and traders do invest in Year 1 that they will recover these investments many times over in future years, there remains the problem of how resource-poor farmers and small traders can fund the initial costs. It will be necessary to consider how a combination of farmers and traders own funds and loan funds can finance these investments. A second consideration is whether, if the investment can be funded, the resulting net earnings of the farmers and traders are attractive enough to make them go ahead. In the case of farmers, the main factors are return on earnings per day of extra work, and to a lesser extent on equity invested (the latter is not often the case for many poor farmers). In the case of traders the main factor is likely to be return on equity .

In reality, the estimates of extra production and volume of trade are uncertain such that the investments have some risk. The technique of "Sensitivity Analysis", explained later, can show how the viability is affected by changes in factors such as falls in crop prices or rises in costs, lower crop yields, or delays in project implementation.

Table 8.3 takes the farm cash flows from the resource flow statement. The farm analysis can be aggregated since we are concerned firstly with average figures. Also the aggregate figures usefully indicate the overall volume of funding required. In our example, seasonal loans at 10% interest are available for up to 75% of farm costs. The balance of funding must come from the farmers own funds (or equity) presumed to be from earnings on other activities. Funds for farm costs are needed at the beginning of the season, initially these are funded by loans and equity. At the end of year 2 there is revenue, after loan repayment, partly for household income and partly to carry forward to fund some of next season's farm costs. By the end of year 4 there is sufficient revenue that no further loans are needed.

The "net incremental household cash flow" after financing shows that the farmers investments of own funds are recovered by year 3. (Discount analysis would show a very high rate of return on this investment.). The return per personday shows how household cash earnings relate to labour effort, and in this example should rise from $3 per day to over $9 after loans are no longer required. The figures can be manipulated to change the balance between cash income withdrawn and funds carried forward, which would affect the loan required the following year. Less withdrawals would reduce loan needs and vice-versa.

Table 8.3 Cash flow statement for a hypothetical agricultural project

Details	*Year*					
	1	*2*	*3*	*4*	*5*	*6*
Before financing						
Incremental farm revenue	0	182000	216000	315000	315000	315000
Incremental farm costs	110000	106500	142000	148000	148000	148000
Net farm cash flow	-110000	75500	74000	167000	167000	167000
After financing						
Balance at start of season	0	0	46250	74138	148000	148000
Cash inflow - equity	27500	26625				
Cash inflow - loans	82500	79875	95750	73863	0	0
Cash outflow - costs	110000	106500	142000	148000	148000	148000
Cash in flow - revenue		182000	216000	315000	315000	315000
Cash out flow - loan + 10% interest		90750	87863	105325	81249	0
Balance after loan repaid		91250	128138	209675	233751	315000
Carried forward to next year		46250	74138	148000	148000	148000
Cash income withdrawn		45000	54000	61675	85751	167000
Equity	-27500	-26625	0	0	0	0
Net incremental household cash flow	-27500	18375	54000	61675	85751	167000
Return to labour						
Cash income	0	45000	54000	61675	85751	167000
Days of family labour	12000	15000	18000	18000	18000	18000
Return per day of family labour	0.00	3.00	3.00	3.43	4.76	9.28

A similar analysis can be made for the net cash flow of traders. For analysis of the return on investment it is necessary to first consider the concept of resources and money over time and the techniques of discounted cash flow in the following section.

DISCOUNTED CASH FLOW

A major concern of economic and financial analysis is the valuation of costs and benefits which occur in the future. A typical investment has a pattern of costs and benefits where in early years costs exceed benefits and in later years the benefits exceed costs. In analysis of whether and by how much overall benefits may exceed overall costs it is necessary to take account of the fact that the values of benefits or costs in say ten years time are less than the same values at the present time.

People have a preference for having benefits earlier than later, that is, they have a positive time preference. The saying "a bird in the hand is worth two in the bush" is at the root of this preference. People prefer benefits or cash now to benefits or cash later for reasons which include:

- The desire to consume goods now rather than delay their enjoyment.
- They can invest resources in alternative activities that give better positive returns e.g. money in a bank can earn interest.
- The expectation of receiving benefits in the future has risk and uncertainty.
- Inflation will reduce the value of any monetary benefits.

In economic analysis the problems of inflation and uncertainty are handled by the use of constant prices and by sensitivity analysis. Since a general inflation of prices does not affect the relative values of costs and benefits, and inflation is difficult to predict, it is practical to use constant prices in cost benefit analysis. Sensitivity analysis calculates the effect on the worth of a project of changes in key variables such as crop prices and various costs. This is explained in more detail later in this chapter. Financial analysis however take account of inflation.

Discounting and the discount rate

To allow for the changes in the time value of money, the terms "present value" and "future value" are used. To calculate the present value of future costs and benefits their future values are "discounted" - reduced from constant price values - back to the present using a discount rate. The concept of discounting is the opposite of compound interest (Box 8.3), whereby a present value grows to a future value because of the accumulation of interest. The discount rate is the reciprocal of the compound factor. An example of discounting is given in Box 8.4.

Box 8.3 Example of compound interest

What will be the value of TSh 100,000 in three years time if the annual rate of interest is 10%?

Each year 10% of the previous value will be added to the total as shown below, the future value can be calculated by multiplying the present/original value by a number - the compound factor.

Year	*Starting value*	*Interest*	*New value*	*Compound factor*
0	100,000	0	100,000	1.000
1	100,000	10,000	110,000	1.100
2	110,000	11,100	121,000	1.210
3	121,000	12,100	133,100	1.331

Where: Future value = Present value x Compound factor

This calculation can be represented algebraically as:

$$FV = PV\,(1 + r)^{t}$$

where r = interest rate and t = time in years

Thus after three years at 10% annual rate of interest Tsh 100,000 is worth Tsh 133,100.

Box 8.4 Example of discount rate

What will be the present value of the cost of TSh 100,000 incurred in the third year of a project if the discount rate is 10%?

Each year 10% of the value will be "lost" as shown below, the present value can be calculated by multiplying the future value by a number - the discount factor:

Year	*Constant price value*	*Discount*	*Value*	*Discount factor*
3	100,000	0	100,000	1/1.000 = 1.000
2	100,000	9,100	90,900	1/1.100 = 0.909
1	100,000	17,600	82,600	1/1.210 = 0.826
0	100,000	24,900	75,100	1/1.331 = 0.751

Where: Present value = Future value x Discount factor

This calculation can be represented algebraically as:

$$PV = FV \times \frac{1}{(1+r)^t}$$

where r = discount rate and t = time in years

Thus a future cost of TSh 100,000 in three years time, using a discount rate of 10% is equivalent to Tsh 75,100 in year "0".

Discount rates can be used to determine the present value of a project's costs and benefits. A simple example of this is given in Box 8.5. Discount factors for different discount rates are tabulated in "discount tables", a copy of which would be useful for all analysts. Discount factors can also be readily calculated using pocket calculators.

Choosing a Discount Rate

Different discount rates can make big differences to the outcome of the analysis of projects. A key decision in project analysis will be the rate used at which future benefits and costs will be discounted. Projects use scarce capital funds for the investments which aim to generate a stream of future benefits, and are usually competing with other projects or investments for that scarce capital. Hence the capital has an opportunity cost which is set by the rates of return on alternative uses of that capital - the opportunity cost of capital (OCC). In its most basic form, an individual considering an investment would look to see what interest could be earned from the alternative of depositing the money in a bank. If banks offered 12% interest then he or she would want a rate of return on the investment of more than 12%. In analysing the future returns on the investment, a discount rate of 12% would be used, and if the discounted future returns of a project exceeded the initial investment then the project is a better investment than putting the money in the bank on deposit.

Box 8.5 Example of the discounting of a project's costs and benefits

The following benefits are expected from a project during its first three years: 2, 3 and 6 million Tsh. What is the present value of these benefits if the discount rate is 10%?

	Year 0	Year 1	Year 2	Year 3
Benefit	0	2,000.000	3,000,000	6,000,000
Discount Factors	1.000	0.909	0.826	0.751
Present Values	0	1,818,000	2,478,000	4,506,000
Cumulative	0	1,818,000	4,296,000	8,802,000

i.e. the total present value of the benefits over years 1-3 will be Tsh 8,802,000.

A similar calculation can be used to discount the costs of the project which for the first three years have been estimated as 4, 2 and 2 Tsh million.

	Year 0	Year 1	Year 2	Year 3
Cost	0	4,000.000	2,000,000	2,000,000
Discount Factors	1.000	0.909	0.826	0.751
Present Values	0	3,636,000	1,652,000	1,502,000
Cumulative	0	3,636,000	5,288,000	6,790,000

i.e. the total present value of the costs over years 1-3 will be Tsh 6,790,000

For projects involving investments of public funds, the OCC will be related to: (i) rates of return possible on other projects or investments which also yield gains to the economy; and (ii), to the costs to the government of raising public finance. Society as a whole may have a rate of time preference lower than that for individuals, shown by positive preferences for long term investments in things like education and pensions, and governments can usually raise finance more cheaply than individuals or businesses. Hence the "social opportunity cost of capital" used as the discount rate in economic analysis of public projects may be lower than commercial rates which may be used in parts of financial analysis.

In practice the project analyst's choice of discount rate will be guided by the planning authorities and by reference to rates used on similar projects. For donor funded projects the donor may have a standard rate. A usual range is between 5% and 15%, and 10% is a rate commonly used although there are different views as to whether this is appropriate.

COST BENEFIT ANALYSIS

Cost benefit analysis is the general term which is used to access present and future costs and benefits of a project. This involves the use of discounted cash flows. There are three standard measures which are general used in cost benefit analysis:- Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). These are discussed in more detail below.

Standard measures - NPV, BCR and IRR

Net Present Value (NPV) is the net sum of total discounted benefits and total discounted costs. This yields a figure showing the excess (or shortfall) of benefits over costs in monetary terms. For example the hypothetical project (Box 8.4) with discounted benefits of Tsh 8,802,000 and discounted costs of Tsh 6,790,000 would have an NPV of Tsh 2,012,000. Generally if the NPV is positive after using a suitable discount rate then the project would be recommended as viable.

Benefit Cost Ratio (BCR) is the ratio of total discounted benefits to total discounted costs. The above example would have a BCR of 8,802,000/6,790,000 equal to 1.30. A BCR greater than one should indicate a viable project.

Internal Rate of Return (IRR) is defined as the discount rate at which the NPV is zero. It is the rate at which the project's benefits are equal to the costs, and reflects the rate at which the project investment is just recovered. Since the IRR is a measure of efficiency it is the most widely used of the measures. It also has the advantage of not requiring a definite discount rate specified in advance. Usually donors and governments have a target rate or cut-off rate and projects with an IRR above the target rate are considered viable.

When considering a number of projects, the funding authorities may want to consider all three measures, but in practice NPV and IRR are most commonly used. Analysis of NPV's can relate the scale of project benefits (increase in national income) to the scale of the initial investment in ways which the relative measures of the BCR and IRR cannot. On the other hand the IRR indicates the relative efficiency of projects which the NPV does not. In the case of mutually exclusive projects, where only one can be chosen because of competition for sites or other resources, the NPV would generally be used rather than the other measures since it will indicate which project yields the greatest addition to national income.

Calculation of NPV, BCR and IRR

In practice NPV's and IRR's can nowadays be calculated very quickly by computer. The following calculations are presented as a guide to understanding the concepts of NPV, IRR and BCR. The following calculations are all based on the data on costs and benefits given in Table 8.4.

Table 8.4 Project data for calculation of NPV, BCA and IRR

Costs/Benefits	*Total*	*Year 0*	*Year 1*	*Year 2*	*Year 3*
1. Discounting Net Benefits					
Investment Costs		8000			
Operating Costs			4000	4000	4000
Gross Benefits			7500	7500	7500
Net Benefits		-8000	3500	3500	3500
Discount Factor 8%		1.000	0.926	0.857	0.794
Present Values	+1020	-8000	3241	3000	2779
2. Discounting Costs					
Total Costs		8000	4000	4000	4000
Discount Factor 8%		1.000	0.926	0.857	0.794
Present Values	18308	8000	3704	3428	3176
3. Discounting Benefits					
Gross Benefits			7500	7500	7500
Discount Factor 8%		1.000	0.926	0.857	0.794
Present Values	19328		6945	6423	5955
4. Discounting to find NPV < 0					
Net Benefits		-8000	3500	3500	3500
Discount Factors 18%		1.000	0.848	0.718	0.609
Present Values	-387	-8000	2968	2513	2132

Net present value (NPV)

The Net Present Value (NPV) is calculated either by:

NPV = Sum of Present Values of NET Benefits

or

NPV = Sum of Present Values of Benefits LESS Sum of Present Values of Costs

From section 1 of the table, discounting the net benefits is the quickest way to find the NPV which is the net figure of +1020 in the total column Section 2 and 3 also give the same NPV calculated as the difference between the present values of benefits (PVB) and present value of costs (PVC), that is 19328 - 18308 = + 1020.

Benefit Cost Ratio (BCR)

The Benefit Cost Ratio (BCR) can have two values, the Gross BCR and the Net BCR. These are calculated as follows:

$$\text{The Gross BCR} = \frac{\text{Present Value Gross Benefits}}{\text{Present Value Gross Costs}}$$

In our example this would be:

$$\text{Gross BCR} = \frac{19328}{18308} = 1.05$$

The Net BCR relates the initial investment to the net benefits in subsequent years, and can be calculated as:

$$\text{The Net BCR} = \frac{\text{Present value of (Benefits - Operating Costs)}}{\text{Present value of Investment Costs}}$$

In our example: the Net Benefits Years 1-3 = 3500 per annum; for which the Present Values = 3241 + 3000 + 2779 = 9020, and hence the net BCR is:

$$\text{Net BCR} = \frac{9020}{8000} = 1.13$$

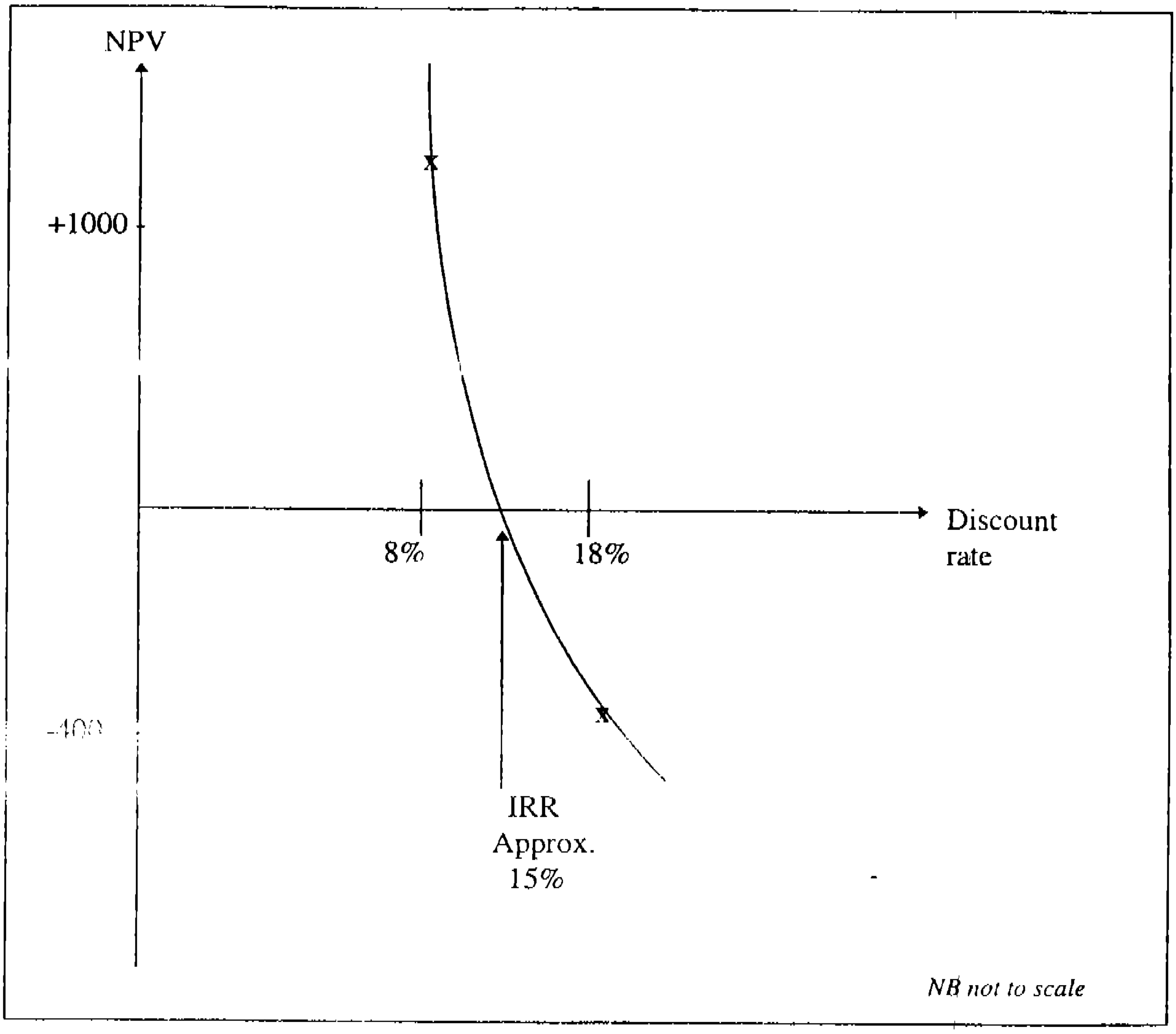
As the BCR can have two meanings and two different values it is important to specify whether the gross or net methods is being used, and not to compare projects using different methods. Since for most agricultural projects it is difficult to separate investment and operating costs and which occur over a number of years the Gross BCR method is usually more appropriate. As already stated BCR is not now commonly used.

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is commonly referred to as to as "rate of return" but it should not be confused with the undiscounted form of rate of return used by accountants in comparing annual earnings to assets. For the above example annual net benefits of 3500 from an investment of 8000 yields a simple rate of return of 3500/8000 or 44% in years 1 to 3. This value does not take account of the time value of money, and it changes over time and is therefore not well suited to project analysis. The Internal Rate of Return is the discount rate which causes the NPV to equal zero, and so represents the discount rate at which discounted benefits equal discounted costs, that is, the rate at which the project is recovering those costs. The mathematics of calculating the IRR involves a process of trial and error or iteration to find the discount rate yielding NPV = 0. The estimation of an IRR can also be done graphically.

From Table 8.4 the NPV with a discount rate of 8% is equal to + 1020. Section 4 of the table shows that with a discount rate of 18% the NPV value reduces to - 387. Hence the IRR, the discount rate for NPV = 0, must lie between 8% and 18%. This can be seen graphically in Figure 8.1. The graph shows that the discount rate giving a zero NPV is approximately 15% which is by definition the IRR.

Figure 8.1 Graphic determination of Internal Rate of Return



Mathematically, the IRR can be estimated using the following formula:

$$IRR = \text{Lower discount rate} + \left(\text{Diff. between discount rates} \times \frac{\text{NPV at lower rate}}{\text{Diff. in NPV at lower \& higher rates}}\right)$$

$$= d_1 + \left[(d_2 - d_1) \times \left(\frac{NPV_1}{NPV_1 - NPV_2} \right) \right]$$

Using the example:

$$IRR = 8\% + \left([18\% - 8\%] \times \frac{1020}{1020-[-387]} \right)$$

$$= 8\% + \left(10\% \times \frac{1020}{1407} \right)$$

$$= 8\% + (10\% \times 0.72)$$

$= 8\% + 7.2\%$

$= 15.2\%$ or 15% rounded to nearest whole number

The above graph and calculation yield estimates of the IRR. In practice the relationship between NPV and the discount rate is a curved rather than straight line. Hence a more accurate estimation of the IRR is possible by using two discount rates closer to the estimated 15%, such as 14% and 16%, and recalculating the IRR. Calculations by computer use this iterative method of using smaller and smaller differences to get closer and closer to the IRR.

Potential pitfalls

It must always be remembered that the technique of cost benefit analysis is based on estimates of costs and benefits which occur many years into the future, and that these estimates are based on numerous assumptions about conditions outside the project's control such as farmer behaviour, commodity markets and government policies. See Chapter 10 for more discussion on the estimation of the costs and benefits associated with projects concerned with small farm developments. The NPV, BCR and IRR calculations shown above are based on one set of cash flows. In practical project analysis there should be consideration of:

- the effect on the NPV, BCR and IRR of possible changes in key assumptions and key variables. This is done by "Sensitivity Analysis"
- various alternative project designs which may have radically different streams of benefits and costs. For example, comparisons of the use of capital intensive construction methods and labour intensive methods.
- the relationship between the financial and economic viability and the associated social, institutional, environmental and technical viability.

There are many examples of unsuccessful projects where in the design of the project planners were tempted to forecast high rates of return based on unrealistic assumptions about aspects of the project and about the external conditions. This may have occurred because for many projects it is easier to rework figures to produce a desired result than to fully investigate the more difficult human and institutional elements. In the final analysis these difficult elements will have more to contribute to the practical success or failure of the project. This is one reason why planners are shifting towards more process projects, and away from the traditional blueprint approach with its emphasis on definitive monetary estimates of project benefits. This also is reflected in the move to attempt to evaluate all costs and benefits of projects, including environmental and social benefit (see Chapter 9) to more fully reflect what actually happens and to help determine the actual costs and benefits of a project.

SENSITIVITY ANALYSIS

The calculation of NPV's, IRR's and BCR's are all based on estimates of project costs and benefits which are subject to varying degrees of uncertainty and risk. When projects are implemented the actual flows of costs and benefits may be significantly different from the estimates. Sensitivity Analysis is a technique whereby the viability of a project is tested against possible variations in the size and timing of the estimated costs and benefits. That is, there is analysis of how "sensitive" the project viability is to various changes in variables. The process of sensitivity analysis is used to recalculate the NPV, IRR and BCR according to various "what if" scenarios such as:

- What if - actual investment costs are *xx%* higher ?
- What if - actual operating costs are *xx%* higher
- What if - actual crop prices underlying benefits are *xx%* lower ?
- What if - actual farm input costs are *xx%* higher ?
- What if - some or all of the project components are delayed by *xx* months ?
- What if - the number of farmers adopting new technology is *xx%* lower ?
- What if - there are *xx* months delay in achieving the target benefit levels ?

With access to computers, the format of resource and cash flow statements and their associated NPV, BCR and IRR can be set up so that changes to various key variables such as crop prices lead to recalculation by the computer of new values for NPV, BCR and IRR. A particular approach to sensitivity analysis is to determine what size change in a variable would cause the project to become non-viable. These changes are called "switching values"

COST EFFECTIVENESS ANALYSIS

In Cost Benefit Analysis (CBA), both the costs of resource inputs and the values of resource outputs must be measurable in market prices, for financial analysis, and as opportunity costs or shadow prices for economic analysis. CBA is then appropriate for projects in the agricultural and industrial sectors where the ultimate aim is to produce tangible benefits in terms of private goods which can be sold in markets. However many occasions arise where benefits cannot be properly valued in monetary terms. In the social and infrastructure sectors, the benefits are usually some sort of public good or service which cannot be fully valued in market terms. Health services, education, water supplies and sanitation, roads, either do not have market values, or attempts at economic values are only partial. Similar cases can arise in agricultural projects where, for example, we may want to know what is the most cost effective soil conservation measure. In these cases, cost-effectiveness analysis is used to answer the question:

> *Which project alternative can produce a set level of benefits (or expected project results) for the cheapest cost ?*

For example, what is the cheapest way to build 10 km of road? Or, should one buy a cheap machine with high running costs, or a more expensive machine with low running costs. A related analysis is efficiency cost-effectiveness where the consideration is, for a set level of costs, which project alternative will yield the maximum benefit. For example, on a budget of X, which project can build the most classrooms? The typical steps in cost effective analysis are given in Box 8.6.

In summary CEA can give good results with which to compare alternative projects or investments where the estimation of financial and economic benefits is impossible or problematic. It can also be used extensively for components within overall projects, such as the choice of machines to be used in a road or irrigation project. However while CEA adds to the information available for decision making on alternative investments or projects, the final decision will depend not only on cost information but also on the technical, social and environmental factors of the project alternatives.

Box 8.6 Steps in cost effectiveness analysis

- Definition of the scope and target population of the project
  (e.g. geographical area, number of households requiring water and sanitation facilities)
- Determination of the benefits wanted from the project
  (e.g. volumes of water, numbers of pipes and latrines, time scale for completion)
- Identification of alternative methods to give required benefits
  (e.g. gravity feed, surface pumping, boreholes)
- Calculation of the monetary costs of the alternative projects
  (e.g. differential capital costs, differential maintenance costs)
- Calculation of either the Present Value of the cost streams from discounting or the Annual Equivalent Value.
- Selection of the project alternative according to least cost and technical, environmental, social and sustainability factors.

Calculation

There are two primary methods used in the calculation of CEA, these are:

- Present Value Method
- Annual Equivalent Value Method

These two methods used in CEA depend on the time scales of benefits and costs. For alternative projects having the same lifetimes of benefits then the Present Value method is used, and where different time spans are involved the annual equivalent method is used. To illustrate these methods two examples are given. In addition secondary methods can be used where total cost is a combination of fixed and variable costs.

Present Value Method

This example involves the construction of a rural all-weather road for which two alternative options have been identified:

- *Option A* which involves machinery-intensive methods, with high initial investment but low maintenance costs.
- *Option B* which involves labour-intensive methods, with lower initial investment but higher maintenance costs.

Initial investment costs for these two options have been estimated as Tsh 60,000,000 for option a and Tsh 8,000,000 for option B. Annual running costs are estimated as Tsh 20,000,000 for option A and Tsh 12,000,000 for option B. Using a discount rate of 10% the present value of the two options over a ten year period would be Tsh 109,200,000 for option A and Tsh 93,700,000. Thus option B, the labour-intensive method, has a lower cost over 10 years, and therefore it is more cost-effective. In practice, the final decision will depend on other factors as well. Such as how reliable is the labour supply, are there good machinery operators, are machine mechanics and spares available, will use of the local community as labour give a sense of ownership, which method will have less impact on the environment. Again in practice, a period of 10 years as given in this example is probable too short a period to consider.

Annual Equivalent Value Method

However when alternative projects have different lifetimes then the Present Value method would not produce comparable results. For example, if two machines with the same output have different working lives then we need some annual equivalent of the total cost of original investment cost plus operating costs for each machine. The method is also applicable where there is an initial investment followed by annual operating costs. To find an annual value for the initial investment extended over the life of the machine we use a Capital Recovery Factor (CRF) which for an initial sum, a discount rate, and a number of years, gives an annual equivalent value for each year. (CRFs are found in published tables, or the calculations can be made by computer or calculator).

For example, for a discount rate of 8% and a ten year life, the CRF is 0.149. An initial investment of Tsh1,000,000 would therefore have an annual equivalent value of Tsh1,000,000 x 0.149 = Tsh 149,000. CRF's are also used in loan repayment calculations, giving the equal annual instalments to repay a loan at a particular interest rate over a set period. In the above case, the method is the same as supposing that the initial investment value is borrowed and then repaid over the life of the machine. An example of the use of this method is given in Box 8.7.

Break-even analysis and cross over discount rate

Break-even analysis can be applied whenever total cost is a combination of fixed and variable costs. As output or capacity increases the fixed costs remain the same but are spread over more output and fixed costs per unit of output fall, and hence total costs per unit fall. Similarly, when output falls, total costs per unit will rise. In comparing two machines or projects with different combinations of fixed and variable costs, one machine may have relatively lower costs per unit at low output but the other may have the lower costs per unit at higher outputs. There will then be some point where both have the same costs per unit. This is the break-even point as shown in Figure 8.2.

Box 8.7 Example of the use of Annual Equivalent Method in CEA

Two machines produce the same output but have different prices, operating costs and life span as detailed below. Which machine should be purchased?

Facts:

	Machine A	Machine B
Initial Cost	4,000,000	7,000,000
Annual Operating Costs	500,000	300,000
Machine Life	10 years	20 years

Using a discount rate of 8% the capital recovery rates for two machines are:

	Machine A	Machine B
Capital Recovery Factor (CRF)	0.149	0.102

The Annual Equivalent Value is calculated by multiplying the initial cost by the CRF which gives:

	Machine A	Machine B
Annual Equivalent Value	596,000	714,000

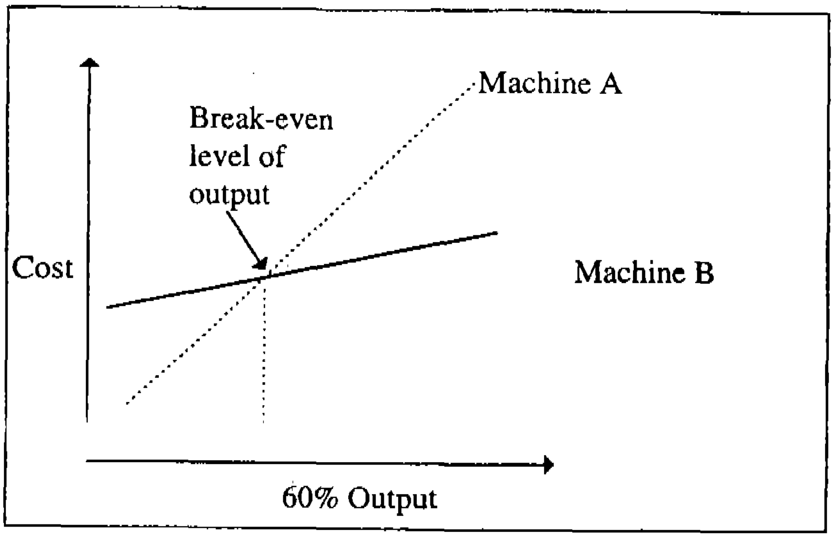
To this has to be added the annual operating costs to obtain the total annual equivalent:

Annual Operating Costs	500,000	300,000
Total Annual Equivalent	1,096,000	1,001,400

From this Machine B is shown by the calculation to have significantly lower costs over its life and on this basis alone would be chosen. However, the final investment decision will depend on other factors such as available funding for the higher investment, longer term risk and availability of spares.

Other important questions for the investment analysis would include how the relative annual cost would change if machines were operating at different levels of capacity and if other discount rates were applied. For these questions further methods of cost-effectiveness can be used.

Figure 8.2 Break-even point



In terms of cost-effectiveness, the choice of which machine to invest in will then also depend on what capacity utilisation to expect. In the example, suppose the machines might only operate at 50% capacity. The initial costs, fixed costs, would be unchanged. However the operating costs can be expected to be lower with the lower output. Three different capacities (50, 60, 100%) are considered below:

	Machine A	*Machine B*
Initial Cost	40,000	70,000
Original Operating Costs	5,000	3,000
Reduced Operating Costs	2,500	1,500

At 100% capacity

Annualised Investment Cost (Fixed Costs)	5,960	7,140
Original Operating Costs	5,000	3,000
Total Annual Equivalent	10,960	10,140

Therefore at full capacity, machine B is more cost effective than A.

At 50% capacity

Annualised Investment Cost	5,960	7,140
Reduced Operating Costs	2,500	1,500
Total Annual Equivalent	8,460	8,630

Therefore at 50% capacity, machine B is now less cost effective than A.

At 60% capacity

Annualised Investment Cost	5,960	7,140

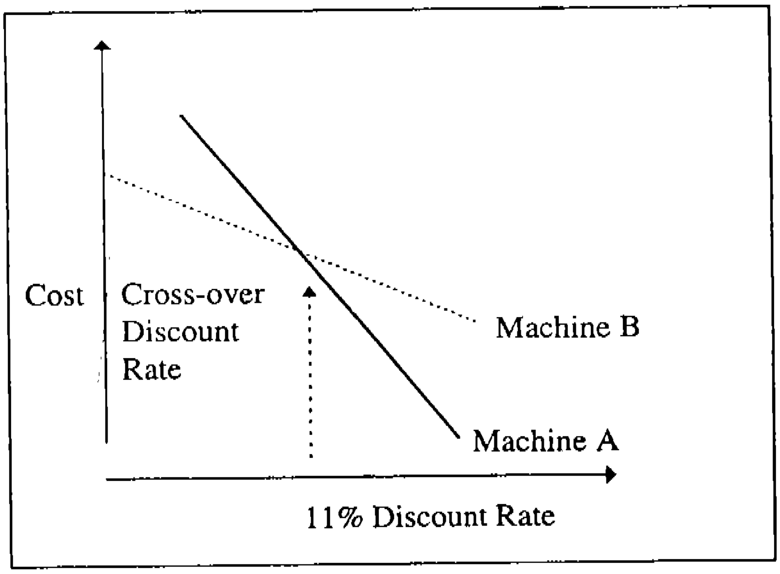
Reduced Operating Costs	3,000	1,800
Total Annual Equivalent	8,960	8,940

Costs for both machines are about the same.

Thus the break-even level of capacity is around 60%. Above 60% capacity machine B is more cost-effective, but below this level machine A is more cost-effective. This kind of analysis is a form of sensitivity analysis. In terms of choosing between the machines, suppliers may claim cost figures based on full capacity. The project analyst should ask: "but what if the machines only run at lower capacities ?"

Another form of sensitivity analysis can be applied to the discount rate. Where there are different combinations of initial investment and operating costs, using a higher or lower discount rate will result in different Present Values or Total Annual Equivalents for both alternatives. At a different rate of discount, what was the more cost-effective investment may become the less cost-effective. The rate of discount where the Present Values or Total Annual Equivalents of the two investments are the same is the "Cross-Over Discount Rate" as shown in Figure 8.3.

Figure 8.3 Cross-over discount rate



In the example of two machines, we can recalculate at different rates of discount and show:

Discount Rate	*Machine A*	*Machine B*
Original 8%	10,960	10,140
Cross-Over Rate 11%	11,792	11,790
Higher Rate 12%	12,079	12,372

The analysis shows that at discount rates below 11%, machine B is more cost-effective, but that at discount rates above 11% machine A is the more cost-effective choice.

ECONOMIC ANALYSIS

Economic analysis and project planning

Economic analysis, when applied to projects, is an analytical tool for planning and research and is a form of the more general tool of cost benefit analysis. The use of the word 'economic' implies the analysis is undertaken is from the point of view of the nation or the economy as a whole. Economic analysis can therefore be seen as a cost benefit analysis from the national perspective. In project planning there are two main objectives to economic analysis:

- To provide information for making decisions on the acceptability of projects from the national point of view.

- To provide information of value for project design and planning, macro economic planning and economic research.

Economic analysis broadens the analysis from confining attention to the project itself to investigating the impact of the project on the national economy. To do this, a number of key steps need to be undertaken and these are common to most approaches to economic analysis of projects. These steps are shown in Figure 8.4. Following these should help ensure that the project contributes to the achievement of some or all the following important economic objectives which a government might consider important:

- Elimination of transfer payments, identification of all the linkage and external effects of the project and valuation of foreign exchange and labour resources in terms of their opportunity cost should indicate the impact of the project on the overall level of GNP and/or welfare.

- Identification and valuation of foreign exchange effects according to their opportunity cost should take account of possible balance of payment constraints.

- Identification and valuation of wage costs according to their opportunity cost might help to take account of problems of unemployment and underemployment.

Figure 8.4 Steps to follow in the economic analysis of projects

	Step	
This may involve several stages and some transfer payments may be more obvious than others.	**(I) Identify and eliminate transfer payments.**	*In eliminating transfer payments it is helpful to record which group makes the transfer payment and which receives the payment.*
This step extends the definition or boundary of the project	**(II) Identify linkages and externalities.**	*Linkages and externalities may be easily quantifiable, while at other times identification and quantification of effects may be more difficult.*
This can show the effect of the project on the availability of foreign exchange. Foreign exchange may then be valued according to its scarcity value or opportunity cost.	**(III) Identify the effect on the use or creation of traded goods.**	*It may also be possible to estimate the effect of the project on the balance of payments.*
In particular identify those categories of labour which are in excess supply.	**(IV) Identify the effect of the project on the employment of labour.**	*In most cases this involves the identification of the payment of wages to unskilled workers and the estimation of the opportunity cost of their employment.*

In addition to the four steps outlined in Figure 8.4 there are two further other steps which have been included in some approaches. These are:

- The effect of the project on the level of investment. This is usually taken to be the same thing as the effect on savings. Estimation of this effect requires some knowledge of the effect of the project on the distribution of income.

- Once the distribution of income has been specified it is possible to consider the effect of the project on the consumption of different income groups.

These two steps would relate to the following government objectives:

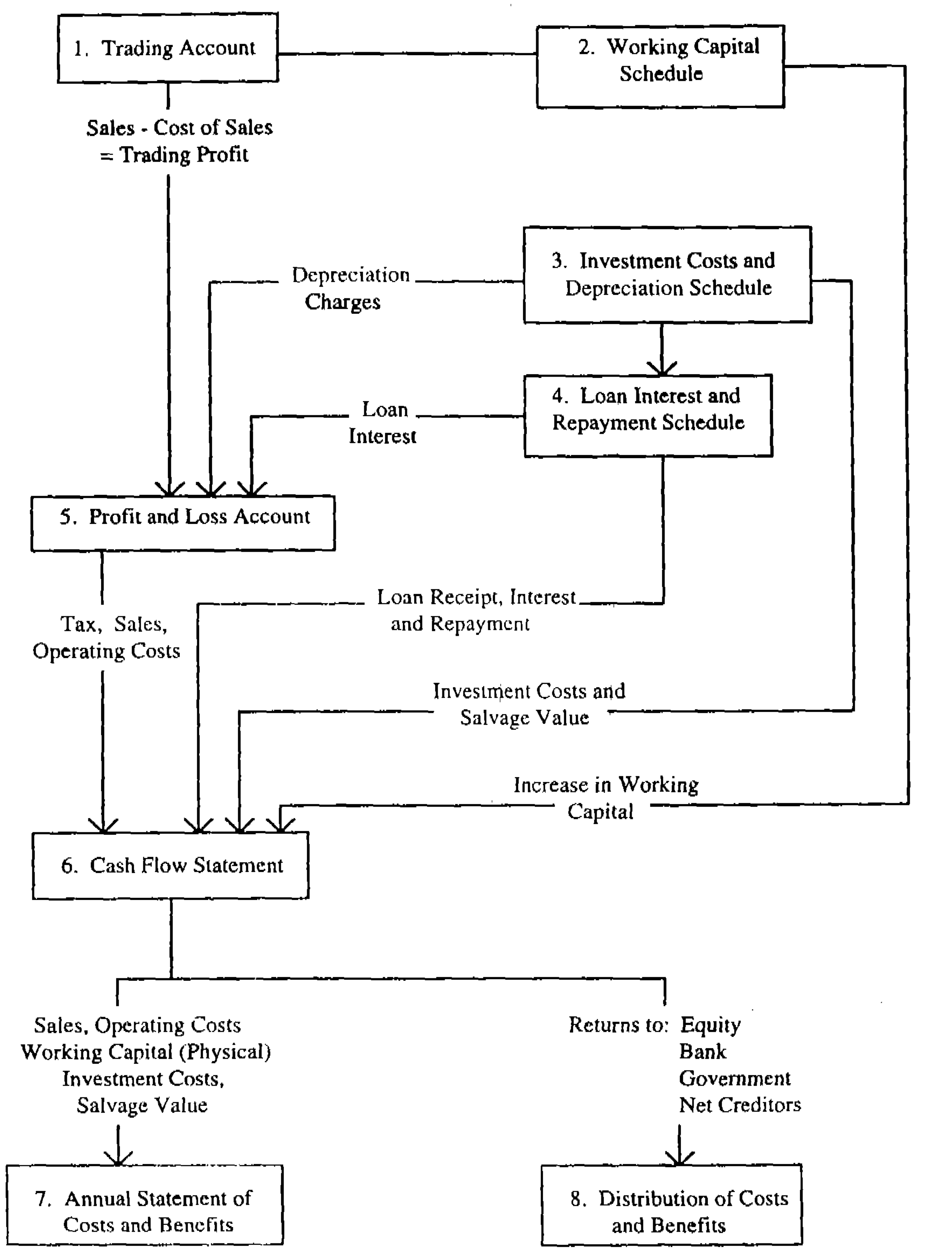
- Identification of savings effects may focus attention on the way these savings may influence the rate of growth of GNP.

- Identification of income distribution effects may show the contribution of the project towards alleviating any income inequalities.

Since the mid 1970's many contributions to the literature on project analysis have made a distinction between economic analysis and social analysis. In the 1980's and early 1990's the attention to the use of project analysis for influencing the distribution of income lessened, partly on the grounds of practicality. This change, along with moves to widen the disciplinary background of those involved in project analysis, has led to the use of the term 'social analysis' in the broader context of examining the social impact of projects. These aspects are discussed in more detail in the Chapters 7 and 9 on project design and environmental assessment. More recently there has been a renewal of interest in the distributional impact of projects associated with attempts to determine the fiscal impact of projects (effect on government income). Estimation of distributional effects can also provide valuable information for stakeholder analysis.

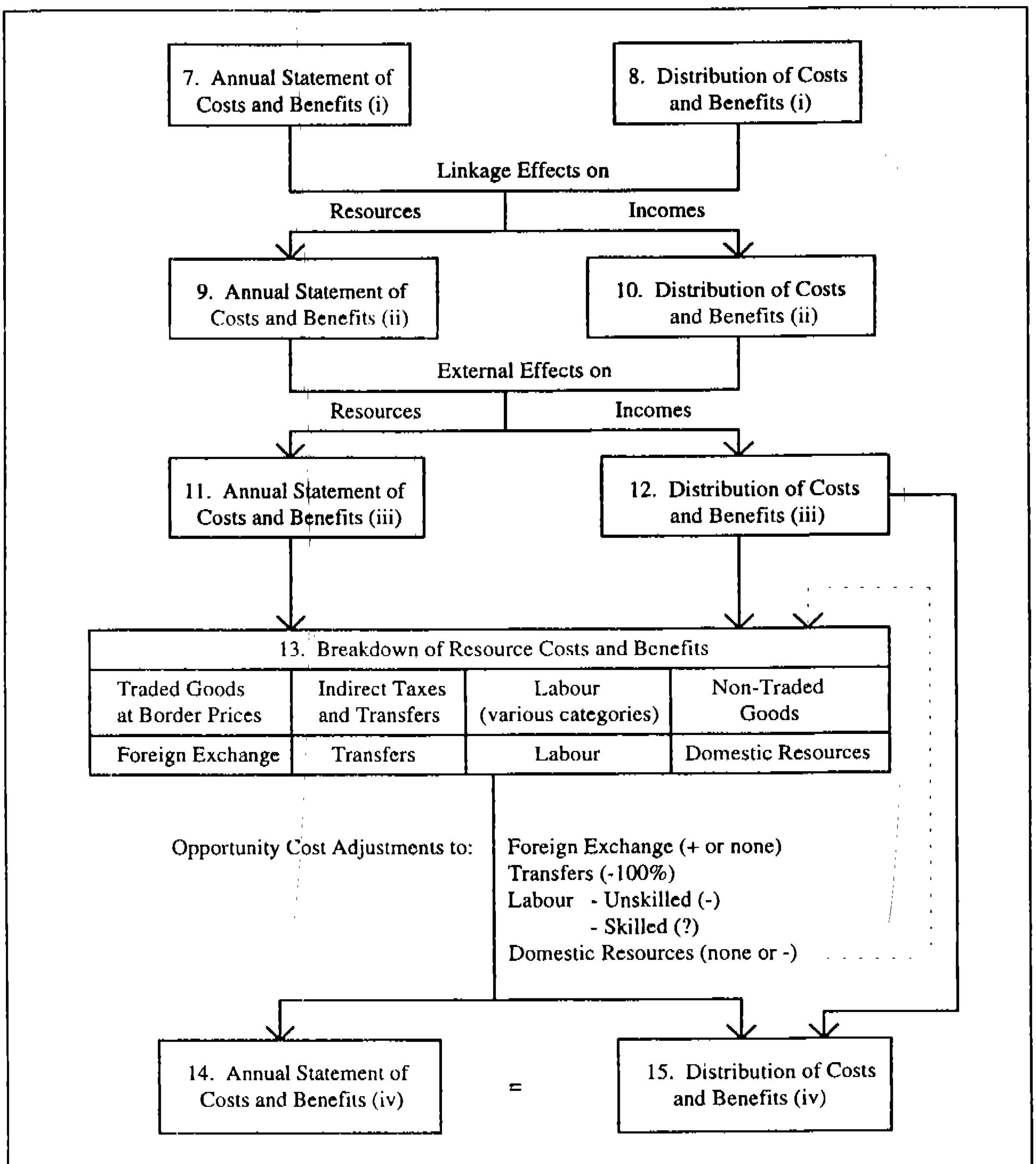
The steps outlined in Figure 8.4 are all concerned with the impact of the project on GNP, irrespective of income distribution. The further two steps outlined above are concerned with the distribution of income between savings and consumption, and between different income groups. These steps are therefore considered in social analysis. A carefully constructed economic analysis should provide all the most important information for the conduct of a social analysis, but it is unusual in practice for any attempt to be made to put different weights on income to different groups as originally proposed in the literature. Figures 8.5 to 8.7 show the structure and relationship between financial, economic and social analysis.

Figure 8.5 Structure of the financial analysis of a commercial project



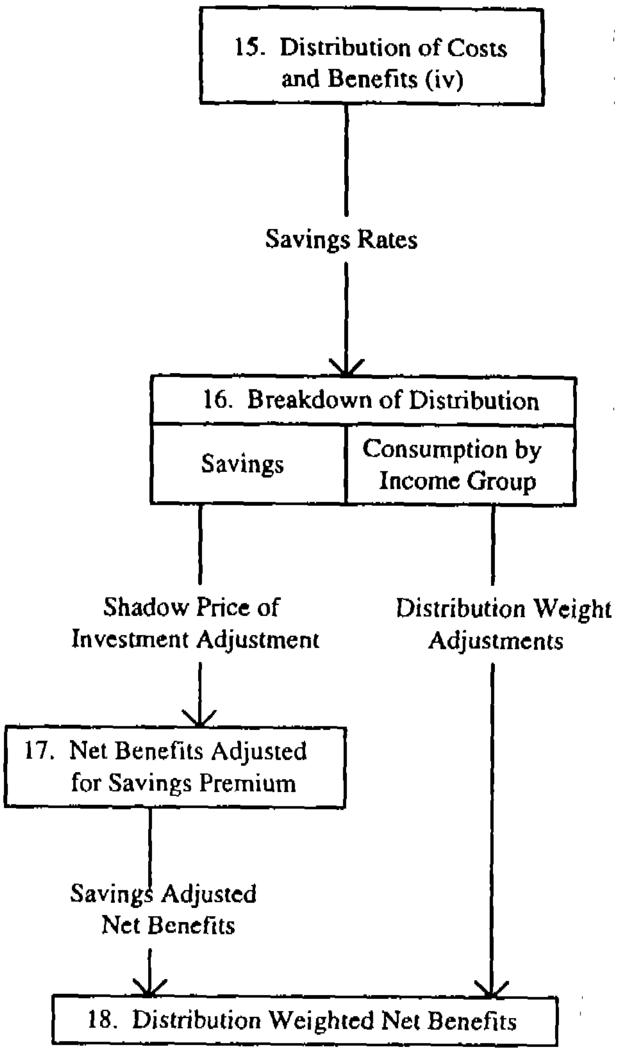
Source: Potts, 1994

Figure 8.6 Structure of economic analysis



Source: Potts, 1994

Figure 8.7 Structure of social analysis



Source: Potts, 1994

Elimination of transfer payments

The structure of a financial analysis for a commercial project is outlined in Figure 8.5. This structure may be different for agricultural projects which do not involve limited companies, but the final output for any financial analysis will be some form of cash flow indicating the expenditures to be made by the project and the sources of funds used to cover these expenditures. This was discussed for agricultural projects earlier in this Chapter. If possible such a financial analysis should be made in current price terms because one of the most important questions to be answered is whether there will be sufficient money available to cover expenditure. Estimation of financial flows in current prices involves the problem of forecasting the likely future rate of inflation - a difficult problem for any period longer than a year or two. For this reason most cash flows are not in practice adjusted for inflation - the alternative being to use some form of price contingency for planning financial requirements in the first few years of the project. Nevertheless, it can be argued that it is better to try to adjust for inflation on the basis of the best information available.

The cash flow statement used for financial planning, in conjunction with the supporting statements, should contain all the information needed for a preliminary economic analysis at market prices. All that has to be done is to eliminate transfer payments and to ensure that the financial analysis is converted back into constant prices if it has been inflated, or otherwise, to ensure that price contingencies are not included in the economic analysis.

Annual Statement of Resource Costs and Benefits

One way to eliminate transfer payments is to draw up a new statement in which they are not included. Such a statement, which should be drawn up in constant prices, is often the starting point in the appraisal of a project and may be undertaken before the financial analysis. The cash flow statement will include, as an inflow to the project, the revenue. The operating costs are included as an outflow. In our annual statement of resource costs and benefits we probably want to list the operating costs and the revenues by categories (see Tables 8.2 and 8.3 for examples from a simple agricultural project). If the operating costs and revenue are expressed in current price terms they should be deflated into constant prices.

The cash flow statement will also include as an outflow from the project the increase in working capital required. Often only physical working capital (i.e. stocks of materials and finished goods) is included as resource costs. Accounts payable and accounts receivable are normally regarded as transfer payments between the providers and recipients of credit. Again, if working capital increases have been estimated in current prices, they should be deflated (converted) into constant prices. Note that accounts receivable for export goods can be considered as a resource cost to the economy because the transfer is between different economies.

The cash flow statement includes investment costs as an outflow. An annual statement of resource costs and benefits at constant market prices consists of sales revenue net of operating costs, working capital and investment costs. Investment costs should therefore be included, deflated into constant prices if necessary, and excluding any price contingency.

What items in the cash flow statement are excluded from the analysis? Credit transfers (accounts receivable ands accounts payable) in working capital have already been mentioned. The other items are:

- *Company taxes.* These are transfer payments from the enterprise to the government.
- *Loan receipt, interest and repayment.* These will normally be transfer payments between the enterprise and the local bank providing the loan. A possible exception is in the case of a foreign loan available only for the project in question. In this case, receipt of the loan could be regarded as a benefit to the economy and loan interest and repayment as a cost.
- *Equity capital.* This is not a resource cost or a benefit, but a source for financing investment costs. Again, a possible exception may exist where there is foreign

investment. Where this is involved, the equity input should be treated as a foreign exchange benefit and the return to the foreign investor as a foreign exchange cost.

Distribution of resource costs and benefits

In these notes an emphasis will be placed on the idea that each resource cost or benefit identified implies a change in the income or welfare of some individual or group. Hence it is possible to draw up a statement of resource costs and benefits and also an exactly equivalent statement on the distribution of costs and benefits. At this stage of the analysis only four groups have been identified. These are the enterprise concerned (the return to equity holders in a commercial project); the government, which receives taxes; the bank which receives loan interest and repayment and pays out the loan principal; and the net receivers of credit. If the incomes to all these groups, when converted into constant prices, are added together, they add up to exactly the same as the total value of net benefits in the annual statement of resources costs and benefits.

How have the transfer payments been eliminated? Taxes are recorded as costs to the enterprise but benefits to the government. Loan payments that are costs to the enterprise are benefits to the bank and vice versa. Credit extended by the enterprise (accounts receivable) is recorded as a cost to the enterprise and a benefit to credit recipients. The reverse applies for accounts payable. In the distribution of benefits statement all transfer payments cancel each other out. In fact this statement establishes the definition of a transfer as a payment to a person or group for which there is no corresponding loss of income, welfare or opportunity to the economy.

Linkages

Often, the financial analysis of a project is confined to the activities of the organisation undertaking the project. For example, financial analysis of a sugar mill would be confined to the inputs and outputs of the mill itself. The 'boundaries' of the project are thus defined as the sugar mill. When undertaking an economic analysis of a project the boundaries are extended to take into account, in so far as possible, the impact on the whole economy. To do this properly it is important to take account of any significant linkage effects.

In the example of a sugar mill, the most obvious linkage is the effect on the farmers who grow the sugar cane. It makes very little sense to confine the analysis just to the sugar mill, since the sugar mill could not possibly operate unless farmers were prepared to grow sugarcane. The definition of the project should therefore be extended to include the impact on farmers. The linkage from the sugar factory to the farmers is an example of a backward linkage that is a linkage back to the producers of the inputs into the project.

Other linkages are forward linkages where it is expected that additional output of an intermediate input will increase the output of industries that use that input. For example, a project designed to increase the output of rice in a particular area may well lead to an increase in the number of rice mills or in the output of existing rice mills.

The most sensible approach to the analysis of linkage effects is to include within the project all those effects expected to be significant. Thus analysis of an agro-industrial project should include an analysis of outgrowers while analysis of crop production projects should include any expected impact on processing industries.

Backward linkages are usually easier to introduce into the analysis - after all production of a certain quantity of sugar will require a quantity of sugarcane determined by technical information on the production process. This is not always the case with forward linkages - particularly where an output can be both a final good or an input into further processing activities. For example, increased output of tomatoes might just affect tomato sales, but it might also lead to an increased output of canned tomatoes or tomato concentrate. It is therefore probably safest to include only those linkages which are known and intended.

Linkage effects are regarded by some economists to be particularly important because they increase the internal integration of an economy and hence its self reliance. These economists would emphasise the importance of strategies which strengthen the links between different sectors and the complementarity of development projects. A possible result might be to analyse a cluster of closely related projects together rather than individually. This approach can perhaps be seen in some of the integrated rural development projects that have been introduced in various countries. In these projects the objective of raising rural welfare is not achieved by a road on its own or an agricultural extension project on its own, but through a combination of roads, extension, credit, water supplies etc. Such projects are usually analysed as a whole so that there is no need to trace the linkage effects, although it may be useful to appraise the contributions of different parts of the project individually as well as together.

Linkage effects are introduced in Figure 8.6. On the resource side the linkage effect will change the values of resource costs and benefits. On the income side, analysis of the linkage will probably indicate an income effect on some group. This income effect will be equivalent to the net resource cost or benefit of the linkage. The linkage argument is particularly important for agro-industrial projects which are usually established because of the complementarity of processing industries with primary production and the constraints imposed on one by lack of development of the other.

Externalities

Externalities can be defined as effects that are imposed by a project on another group of people without any direct payment being made. They can include both external costs and external benefits and both effects which are quantifiable and can be valued as well as effects which are intangible - important but not possible to value.

Agro-Industrial projects may have very significant external effects. Processing projects can affect each other by inducing farmers to change from one cash crop to another. The introduction of cash crops related to a processing facility may affect the supply of food crops and therefore the price and availability of food. Effluent from processing facilities may affect water supplies downstream of the factory. Roads may be constructed to service a processing facility although they are also used by local people for other purposes - an example of an external benefit.

Wherever possible, account should be taken of external effects. In particular it is important to determine whether, on balance, externalities are positive or negative. If possible external costs and benefits should be valued and 'internalised' into the analysis of the project. For example, analysis of projects involving changes in crop production should include not just the crop in question, but also any effects on the production of other crops. If there is reason to believe that establishment of a new processing facility will have an impact on the supply of raw materials to another competing factory, that effect should be included in the economic analysis.

Sometimes quantification of externalities is impossible. In such cases it is useful at least to mention the existence of the externality and to provide any relevant information to provide the basis on which a decision could be made. Environmental and social impact effects are often difficult to quantify but they should not be ignored if they are known to be significant. Decisions are not made on the basis of numbers alone and relevant qualitative information can be of equal or even greater importance. In the field of environmental analysis considerable work is now being undertaken to develop methods of including environmental impact in the analysis of projects (for further discussion on these issues see Chapter 9 on environmental assessment).

Opportunity costs

Opportunity cost is the most important concept underlying economic analysis. It is defined as the next best alternative foregone in undertaking a course of action. Whenever the opportunity cost of an item is not equal to its price there is an argument for using shadow prices. Opportunity cost can best be explained by reference to examples commonly used in the economic analysis of projects: land, labour and capital.

Opportunity cost of land

The opportunity cost of land can be investigated by asking what are the alternative uses of the land. Urban land can be used for houses, offices, shops and factories. Rural land is normally used for crops, pasture, forestry or sometimes conservation. The opportunity cost of rural land is likely to be very important in the assessment of any agricultural or agro-industrial project. Usually a financial analysis of a project will put the cost of land down as a single capital item (land purchase) or an annual payment (land rental). From the point of view of the land holder, its opportunity cost is the market value of the surplus produced by that land in its next most profitable use. If the land is rented this opportunity cost might be expressed as the present value of the expected future surplus.

The opportunity cost of land can be looked at from at least two perspectives - those of the land holder and of the national economy. The land holder may conceive of opportunity cost as the market value of foregone rent but, from the viewpoint of the national economy, it is the value of the surplus produced from that land to the economy as a whole. This may include production by people or enterprises using that land. The rent to the landlord would then be regarded as a transfer from one group to another and the value of the land would be defined as the production derived from the land net of the cost of production.

Sometimes land may be valued at its opportunity cost when backward linkages to farmers are considered. For example, a proposed sugar mill may induce farmers to change from growing bananas (the next best alternative crop). The opportunity cost of the land is the expected surplus (or gross margin) earned from bananas. Sugarcane costs may be valued in terms of the lost production of bananas net of any difference in production costs. In doing this, the opportunity cost of land has been taken into account implicitly through the specification of the 'with' and 'without' project situations.

The opportunity cost of land in any case is really the surplus foregone in changing land use. It is usually assumed that this value remains constant over the life of a project. However, it is important to recognise that if, without the project, this surplus is expected either to increase or decrease (e.g. increasing or decreasing yields) some account should be taken of the likely change in the opportunity cost of land.

Opportunity cost of labour

The opportunity cost of labour usually varies significantly between occupational groups and often between regions. Project appraisals usually distinguish between skilled and unskilled labour, the most common assumption being that skilled labour is in scarce supply and has an opportunity cost equal to or greater than its market price, while unskilled labour is in excess supply and has an opportunity cost below its market price.

The first assumption implies that skilled workers are able to obtain the same salary whether they work on the project in question or on another project. Such an assumption is probably reasonable for most countries - including Tanzania - and any other assumption is difficult to make. In some countries, particularly those undergoing very rapid structural change, there may be a shortage of skilled labour. This does not mean that skilled workers earn less on the project under consideration than in their alternative occupations (in that case they would not move) but it may mean that their employment imposes losses on other activities which lose their services and it is possible that such losses could be greater than the saving in salaries.

The opportunity cost of urban unskilled labour depends on alternative employment possibilities. Where unemployment is high and workers do not have access to land as an alternative source of income, the opportunity cost of labour may be very low. This may be the case in highly urbanised societies or where population density is high. Even in these cases it is unlikely that the opportunity cost will be zero. There are some additional costs, such as transport, involved in going to work and unemployed workers may also have some alternative sources of income at certain times of year (for example periods of peak labour demand in the rural areas). To the workers themselves the opportunity cost of going to work is also affected by social security payments even though, from a national point of view, these would be regarded as transfer payments.

Ideas about the opportunity cost of formal sector unskilled labour usually stem from theories of migration. Unskilled workers migrate from the rural areas and the 'informal sector' to the urban areas and the 'formal sector' in search of higher earnings. This has happened in the course of the development of almost every country in the world and occurs most readily when there is a significant gap between urban and rural wage levels.

It is usually supposed that the opportunity cost of formal sector unskilled labour is the value of alternative earnings in rural areas, either as a small farmer or as a casual labourer. The most common form of estimate would be the casual daily wage rate multiplied by the number of days worked in a year. Such estimates can be very crude or they could be a result of a detailed survey of unskilled labourers and migrants from the rural areas.

The opportunity cost of unskilled rural labour (e.g. casual agricultural labourers) is usually assumed to be equal to the market wage if there are no institutional regulations preventing the equalisation of the supply price of labour and the market wage. Whether this is the case or not depends on how the labour market works in the rural areas. Even where the market wage is relatively freely determined, there may be some circumstances when it is necessary to pay closer attention to the value of the commodities produced by the labourers, particularly if the opportunity cost of those commodities does not correspond to their market price.

Opportunity cost of capital

The opportunity cost of capital (investment funds) for an individual, a company or an economy is the rate of return available on the next best alternative project. For an individual or a company, commercial rates of interest may give a reasonable guide - the alternative to investing in a project is to lend your money to a bank or to some other organisation offering a rate of interest. Note that market interest rates are influenced by the rate of inflation and cannot be used in any constant price analysis unless they have first been adjusted for expected future inflation to give an estimated real rate of interest.

For an economy, estimation of the opportunity cost of capital may be difficult. It is necessary to have an idea of the likely rates of return on different possible investment projects. One way would be to rank all possible projects according to their IRR and to draw a cut off line where investment funds are exhausted. In practice it is unlikely that projects can be listed very easily in this way, particularly when funds are being used in sectors such as health and social services where benefits are hard to enumerate, or when it is difficult to transfer investment from one sector to another. Estimation of the opportunity cost of capital for the national economy is the same as estimation of the discount rate to be used in economic analysis (see later section).

Opportunity cost and traded goods

Traded goods are those goods which are imported or exported. The opportunity cost of traded goods to an economy is the border price (c.i.f. for imports and f.o.b. for exports). For example, a country may be able to produce sugar to satisfy the local market. The alternative is to import the sugar. The value of the sugar produced is then the c.i.f. price which has been saved. Similarly, a textile project may use locally produced cotton lint as a raw material, the alternative being to export the cotton lint. The opportunity cost of using the cotton lint for the textile project is the export price (f.o.b.) foregone. Note that for some commodities the relevant world price may be hard to identify. This is the case for commodities such as sugar where the world market is the small residual that lies outside commodity agreements.

All commonly used methods of economic analysis use border prices in the valuation of traded goods. This does not imply acceptance of the justice of the existing international economic order or a commitment to free trade. It is merely a recognition that trade is an alternative opportunity to local production. Some commodities may be tradable but not traded. This occurs when the import of commodities that are produced locally is restricted. Should trade be regarded as an opportunity cost? This really depends on whether there is any likelihood that the government will change its policies. If it will not there is no point in regarding trade as a possible opportunity, since the government has excluded the possibility of trade. Definitions for traded and non traded goods are given in Box 8.7.

Opportunity cost and non traded goods

Some goods are non traded because of government policies. Others may be non-traded because trade is either impossible or pointless. For many countries water supply is non traded as is internal transport and the production of many building materials. What is the opportunity cost of using these items?

The answer to the question really depends on whether use of the item in question will cause more units of that item to be produced or whether it will deprive another person of its use. If more items are produced, the opportunity cost is the cost of producing the extra items. If an alternative user is deprived of the use of that item, the opportunity cost is the price that the alternative user would have been willing to pay - normally the local market price. It is usually assumed that, over the life of a project, the production of most non-traded goods can be expanded to meet additional demand, and therefore that the relevant opportunity cost is the long run marginal cost of production.

Box 8.7 Definitions of traded and non-traded goods

Traded goods or services - are those in which international trade occurs, and could be exported or imported by a country.

Non traded goods or services - are those for which there is no international market, and are not exported or imported by a country.

Cost breakdowns

One approach to economic analysis is to try, in so far as possible, to break down all costs and benefits into basic categories. Shadow prices can then be applied to these basic categories. A typical list of categories would be:

Foreign Exchange	(F)	Domestic Resources	(D)
Skilled Labour	(W)	Taxes and Transfers	(T)
Unskilled Labour	(L)		

Some of these categories could be further broken down into various types of skilled labour or in the case of taxes and transfers into taxes and excess profits. How can costs (or benefits) be broken down? Some items are easier than others and traded goods are easier than non-traded goods. Some examples are given in the following sections.

Labour

A project employs 410 workers at a total cost per year of $250,000. There are 60 skilled workers earning an average of $1250 and 350 unskilled workers earning an average of $500. The breakdown of labour costs is:

$$\text{Skilled (W)} = \frac{(60 \times 1250)}{250{,}000} \times 100\% = 30\%$$

$$\text{Unskilled (L)} = \frac{(350 \times 500)}{250{,}000} \times 100\% = 70\%$$

The breakdown of wage costs is therefore 30% W, 70% L.

Traded goods (export)

A project is set up to produce bananas for export. The project is paid $195 for each ton of bananas. The f.o.b. price of bananas is $240 per ton. Boxing, transport and handling cost $30 per ton. The government charges $10 per ton export duty and the marketing board makes $5 per ton excess profits. The basic breakdown for bananas is:

$$\text{Foreign Exchange (F)} = \frac{240}{195} \times 100\% = 123\%$$

$$\text{Domestic Resources (D)} = \frac{-30}{195} \times 100\% = -15\%$$

$$\text{Taxes and Transfers (T)} = \frac{-15}{195} \times 100\% = -8\%$$

Transfer payments could in turn be broken down into taxes and excess profits. If sufficient information were available, the local cost (D) of handling etc. could be further broken down. Note that, as is often the case for exports, the foreign exchange content is over 100% because the f.o.b. price exceeds the price paid to the project. The other items represent the additional costs (handling etc. and duties) which cause the f.o.b. price to exceed the price to the project. They are therefore negative.

Traded goods (import substitution)

A project is to be set up to produce tea in an area where farmers are currently growing maize. The project area normally sells its surplus maize to the urban areas which would otherwise rely on imported maize. The project is expected to result in a decline in the quantity of surplus maize. Maize is sold by farmers at $6.30 per kg. but can be imported at a c.i.f. price of $5.75 per kg. Transport costs from the project area to the wholesale market are $0.93 per kg and transport of imported maize from the port to the wholesale market costs $0.35 per kg; the government charges 20% duty on imported maize ($1.15 per kg); port charges for imported maize are $0.36 per kg.; locally purchased maize has an administrative and marketing cost of $1.20 while for imported maize it is $0.25 per kg; the maize marketing board makes an excess profit of $0.57 per kg. on imported maize. Transport costs are estimated to have a foreign exchange component of 45% and a tax component of 25%. All other costs other than duty are assumed to be local. The breakdown of the price paid to farmers is estimated in Table 8.5.

Table 8.5 Cost breakdown for imported and locally produced maize

Details	*Total ($)*	*Breakdown ($)* F	D	T
With the Project				
Price to Farmers	6.30			
Transport from Farm to Market	0.93	0.42	0.28	0.23
Administrative and Handling Costs	1.20		1.20	
Cost of Maize to Market	**8.43**	**-0.42**	**-1.48**	**-0.23**
Without the Project				
CIF Price	5.75	5.75		
Import Duty	1.15			1.15
Port Handling Charges	0.36		0.36	
Transport from Port to Market	0.35	0.16	0.10	0.09
Administrative and Handling Costs	0.25		0.25	
Cost of Maize to Market	**7.86**	**5.91**	**0.71**	**1.24**
Net Loss to Marketing Board	**0.57**			**0.57**
Breakdown of Farm Gate Price	**6.30**	**5.49**	**-0.77**	**1.58**
%		**87.1**	**-12.2**	**25.1**

F - Foreign Exchange; D - Domestic Resources; T - Taxes and Transfers

The local price of maize is made up of 87.1% foreign exchange, 25.1% import duties and other transfers, and -12.2% local resources. Thus if we were to convert this to Tsh then for every Tsh 1,000 worth of local maize production lost, Tsh 871 worth of foreign exchange is lost while Tsh 251 worth of duties and excess profits are lost by the government, and Tsh 122 worth of local resources that would have been used in marketing the local maize are saved.

The breakdown in this case shows both the primary breakdown into cost components and also a secondary breakdown of the cost components themselves into basic resource categories. A more detailed example of how a breakdown of transport costs can be determined is illustrated the next example of non-traded goods.

Non-traded goods

Most projects involve some road transport costs. It is therefore worthwhile to have some centrally available estimate of the breakdown of road transport costs. A typical estimate of a breakdown for road transport costs is shown in Table 8.6 (based on annual values ($) per truck).

Table 8.6 Cost breakdown for transport costs of a project

Details	*Total ($)*	*Breakdown ($)* F	W	L	D	T
Diesel and Lubricants	9600	8160			960	480
Tyres	6300	2835			2520	945
Maintenance and Spares	6400	3328	768	512	1280	512
Labour	1250			1250		
Other Expenses	4000		900	600	2500	
Insurance	1150				1150	
Road Tax	350					350
Annualised Value of Capital Costs	11850	6636			1896	3318
Total Costs	**40900**	**20959**	**1668**	**2362**	**10306**	**5605**
Revenue	**42500**					
Excess Profit to Owners	1600					1600
Allocated Road Maintenance Costs	1750	1050	140	210	280	70
Government Expenditure on Roads						-1750
Total Breakdown	**42500**	**22009**	**1808**	**2572**	**10586**	**5525**
%		51.8	4.3	6.1	24.9	13.0

F - Foreign Exchange; W - Skilled Labour; L - Unskilled Labour; D - Domestic Resources; and, T. - Taxes and Transfers

The first step is to collect data on the cost composition of the activity concerned. The major difficulty lies in the estimation of an annual equivalent of capital costs. Depreciation estimates are not reliable because they are based on historic costs which do not take account of inflation and because they do not take account of the opportunity cost of capital. The most satisfactory approach if the data are available is to apply a capital recovery factor to the current value of the investment item in question. This is how the annual equivalent of the cost of the truck was calculated. In the case of transport costs a second complication occurs because vehicles make use of roads for which they do not pay directly. In principle the breakdown of the economic value of transport costs should include an estimate for the additional cost of road maintenance incurred when extra vehicles use the roads. This item would not appear in the cost structure of transport enterprises and so a balancing item would have to be included under the transfer payments for the extra government expenditure caused by extra road use.

Other non-traded items for which such data might be collected centrally are construction, electricity, local trade and rail transport.

Semi-input-output analysis

In recent years the kind of information required for estimating cost breakdowns has been generated in a number of countries through the use of semi-input-output analysis in which an economy is divided into a number of traded and non-traded sectors and an attempt is made through the use of input-output analysis techniques to break down (decompose) the value of the output into basic categories (primary factors). This technique is used particularly in generating general sets of shadow prices for economies as discussed in the next section.

Shadow prices

Shadow prices for economic analysis are based on opportunity costs. If costs can be broken down into basic resource categories on an opportunity cost basis, all that remains to be done is to value the basic categories according to their opportunity cost. This is now discussed below.

Conversion and adjustment factors

For convenience, shadow prices are often applied using either conversion factors (CF's) or adjustment factors (AF's). These are defined as follows:

$$CF = \frac{\text{Shadow Price}}{\text{Market Price}}$$

$$AF = \frac{\text{Shadow Price}}{\text{Market Price}} - 1 \quad \text{x } 100\%$$

Shadow values in a statement of project costs and benefits can be found by:

- multiplying the market price values by the conversion factor; or
- multiplying the market price values by the adjustment factor to give the value of the adjustment which is then added to the market price value.

Taxes and transfer payments

These are the easiest to deal with as they have an opportunity cost of zero. As always in an economic analysis taxes and transfer payments, once identified are eliminated. Two methods of eliminating transfer payments can be used. Either they are multiplied by a conversion factor of zero or they are adjusted by an adjustment factor of -100%. The effect of course is exactly the same. An advantage of the adjustment factor approach is that the value of the adjustment will correspond exactly with the income change to the recipient of the transfer payment. In the case of taxes, the recipient is the government. Excess profits go to the company that receives the profits.

Labour

Earlier it was suggested that skilled labour is usually assumed to have an opportunity cost equal to the domestic market wage. When this is the case, no adjustment need be made to skilled labour cost items. This is usually the case for Tanzania. Again in many countries unskilled labour is assumed to have an opportunity cost below the market wage. In urbanised societies this is reflected in the level of unemployment. For the rural areas it was suggested that the opportunity cost might be estimated on the basis of the average daily wage rates of casual labourers in the rural areas and the number of days worked by such labourers in a year.

In principle the shadow wage rate is determined by the opportunity cost of labour which may be adjusted for any difference between the shadow price and market price of the commodities produced by workers in their alternative occupations. This can be important when the shadow value of output in the rural areas is either considerably above or below the market value. In many countries such workers (i.e. small farmers) produce crops whose value in domestic prices is considerably below their value at border prices. In such cases a further adjustment should be made to the shadow wage to reflect the extent to which domestic prices undervalue the output of farmers. The conventional approach to estimating the shadow wage rate is to adopt the following procedure:

- Determine the opportunity cost of labour (m) by finding out the next best alternative occupation for labour of the category under consideration and the number of days worked (n).

- Estimate the additional costs (x) associated with transfer to work with the project from the alternative occupation.

- Estimate a conversion factor for the output of the worker in the alternative occupation without the project (a).

The shadow wage rate (SWR) is then given by:

$$SWR = mna + x$$

For example, if the average daily casual wage rate is Tsh 2,500 and workers are able to obtain 150 days work in a year, the conversion factor for the alternative output of the worker is 0.8 and the extra cost of transferring the worker to the new occupation is Tsh 120,000 per year, the SWR for unskilled workers would be [(2,500 x 150 x 0.8) + 120,000] = Tsh 420,000 per year.

When the SWR is below the market wage rate, use of the SWR for project selection will encourage projects which employed unskilled labour. Although it is useful to have an average national estimate of the SWR, it is also likely that there may be considerable regional variations so that the SWR will be at least regionally specific and possibly even specific to a particular project. The conversion factor or adjustment factor for unskilled labour may also be project specific because market wages may differ. For example:

if SWR = 420,000 per year

Market wage for workers in Project A = 500,000 per year

Market wage for workers in Project B = 600,000 per year

$$CF(A) = \frac{420{,}000}{500{,}000} = 0.84$$

$$CF(B) = \frac{420{,}000}{600{,}000} = 0.70$$

$$AF(A) = \frac{420{,}000}{500{,}000} - 1 \times 100\% = -16\%$$

$$AF(2) = \frac{420{,}000}{600{,}000} - 1 \times 100\% = -30\%$$

Although the shadow wage itself is the same, the CF's and AFs are different.

The conventional approach to the estimation of the shadow wage rate and its associated conversion factors assumes that the various parameters used in the calculation are easy to identify and measure, and reasonably stable.

Foreign exchange

Shortage of foreign exchange is a significant constraint in many countries. Where this is so, it may be argued that the official exchange rate understates the value of foreign exchange and that a shadow exchange rate (SER) should be used in project analysis. Use of an SER should encourage those projects which either save or earn foreign exchange and discourage those projects which use foreign exchange.

Shadow exchange rates are usually expressed as conversion factors or adjustment factors to be applied to the official exchange rate rather than as a rate of Tsh. to the US$ of £. The reason is that we are concerned with the value of foreign exchange as a whole rather than the value of particular currencies. The only exception is that a different CF and AF might be used for currencies that are not freely convertible and may therefore be less valuable than freely convertible foreign exchange.

The most commonly used method of estimating shadow exchange rates is to measure the extent to which the local prices of traded goods exceed the world prices of such goods. This difference between local prices and world prices is usually reflected in the levels of import duties and export subsidies. The shadow exchange rate should really be an estimate of the opportunity cost of foreign exchange. This can be interpreted as the relationship between the value of imports no longer available (or the value of additional exports required and therefore not available for local consumption) and the amount of foreign exchange spent. For example, a project may require an imported machine costing Tsh. 10 million c.i.f. at the official exchange rate. That Tsh 10 million of foreign exchange expenditure must either be covered by decreased imports or by increased exports.

Suppose that imports are reduced by Tsh 6 million and exports increased by Tsh 4 million and that import duties are charged at a rate of 20% while exports are taxed at 5%. The local market value of the imports and exports no longer available is (6 x 1.20) + (4 x 0.95) = Tsh 11 million. The local market price of imports is higher than the world price because of import duties, but the local price of exports is lower because of the export tax. Expenditure of an additional Tsh 10 million in foreign exchange has reduced the value of goods available on the domestic market by Tsh. 11 million. The government has lost Tsh 1,2 million in import duties and gained Tsh. 0.2 million in export taxes. The ratio of the value of traded goods at domestic prices (Tsh 11 million) to the value of those goods at world prices (Tsh 10 million) is 1.10. The shadow exchange rate CF is therefore 1.10 and the AF is + 10%.

More complex formulae for the SER than those in Box 8.8 can be derived if information is available to indicate the types of imports or exports which change with a change in the availability of foreign exchange. It is also possible to try to take account of non-tariff trade restrictions such as import quotas, which may have the same effect as import duties in raising local prices. The question as to which formula is appropriate is essentially an empirical question, but it is probably fair to suggest that the appropriate value will, in most cases, lie between the values given by formulae i) and ii) and will probably be nearer to formula ii) if account is taken of quantitative trade restrictions.

In cases where quantitative restrictions are very significant the value of the SER may be well above the estimate given by either formula. Under such circumstances estimation of the SER becomes very difficult and the only approaches readily available are direct comparison of local and world prices or reference back to a period when quantitative restrictions were not so important and tracing movements in local prices, world prices and exchange rates.

As with the estimation of the shadow wage rate, the estimation of a shadow exchange rate is particularly difficult in a country undergoing rapid economic change. This is because the exchange rate is likely to be at a real level that is significantly different from the likely level in the long run. As with the shadow wage rate, a sensitivity analysis approach might be appropriate and this would imply use of the domestic resource cost of foreign exchange measure (see later section for more details).

The discount rate

The discount rate appropriate for economic analysis is the opportunity cost of capital measured at shadow prices. Three possible approaches to estimating this parameter are:

(i) *Evaluation studies.* A number of projects could be evaluated at shadow prices to find out their economic rate of return. A rough estimate of the opportunity cost of capital might be obtained by using the lower end of the range of rates of return.

(ii) *Macro-economic data.* Using national accounts data and input output tables, it is possible to estimate the total amount of value added in the economy and the value of the capital stock used to produce it. Though measuring the value of capital is one of the central theoretical problems of economics and is beset by difficulties. Some of the value added will represent a return to various types of labour and land. Both the value added and the returns to labour and land should be measured in shadow prices. The remaining value added may be assumed to be the return to capital and the ratio of this value added to the value of the capital stock gives an estimate of the opportunity cost of capital. Such estimates are almost invariably overestimates for a number of reasons:

- It is an average figure while the opportunity cost of capital is a marginal concept - the lowest acceptable rate of return before investment funds are exhausted.

- Use of the shadow wage rate understates the contribution of labour. It may be possible to use unskilled workers on an additional project at a relatively low opportunity cost in terms of foregone production, but it would not be possible to transfer all workers at such a low cost in production.

- Historic cost data on the value of the capital stock understate its value.

- The residual method of apportioning returns to capital tends to lead to overstatement - all technical progress is assumed to be a return to capital.

Macro economic approaches to the estimation of the opportunity cost of capital are therefore not very reliable unless very carefully conducted.

(iii) *Trial and error.* The discount rate can be treated as an unknown. An initial figure might be selected - most countries seem to choose about 10% although this may be rather high. That figure could then be adjusted in the light of experience. If too many projects are accepted, the discount rate could be raised; if not enough are acceptable, a lower discount rate could be used.

iv) *The real cost of borrowing.* Many countries borrow money from abroad to finance at least part of their investment requirements. It can be assumed that borrowing money from abroad is one possible option and that, if a country is considering this option, the economic rate of return on the project should be at least equal to the real cost of borrowing. In practice this approach is quite common and, for this reason discount rates for most countries tend to lie in the range 5% to 15%.

Application of shadow prices

If all cost and benefit items have been broken down into basic resource categories, the application of shadow prices is very simple. The value of each category in each year can be multiplied by the CF or AF for that category. If CF's are used, the converted values for each year are added up to give the economic value of net benefits. If AF's are used, the adjustments are added to the net benefits at market prices to give the economic net benefits. The result can be discounted at whatever is the selected discount rate. A summary of the effects of using shadow prices on the valuation of the various categories is given in Box 8.9.

Box 8.9 Effects of shadow prices of the valuation of different resources

Resource Category	Effect of Shadow Pricing	CF	AF
Taxes and Transfers (T)	Eliminated	0	-100%
Skilled labour (W)	Probably unchanged	1	0%
Unskilled labour (L)	Reduced	<1	- ?%
Foreign Exchange (F)	Increased	>1	+?%
Domestic Resources (D)	Unchanged	1	0%

Economic analysis using a world price numeraire

Two of the most influential works on economic analysis of projects are those by Little and Mirrlees (LM) and Squire and van der Tak (SVT). These works were commissioned by the OECD and the World Bank respectively and put forward a method which is used by the bilateral aid agencies including Britain, USA and Germany. The method is also used by the World Bank. The two works can be regarded as different variants of the same method and they share in common what has been described as a world price numeraire.

The numeraire

A numeraire is simply a French word for numerator or unit of account. In any system of measurement there must be a unit of account. For example weight can be measured in kilograms or pounds - it doesn't matter which because the weight is the same and there is a constant relationship between weight measured in kilograms and weight measured in pounds, i.e.2.2 lbs = 1 kilogram).

Costs and benefits are usually measured in the local currency. When we calculated the shadow exchange rate (SER), in effect we stated that Tsh. 1.00 worth of foreign exchange was worth more than Tsh. 1.00 of domestic resources and that the SER measured the value of a unit of foreign exchange in terms of domestic resources. Units of domestic resources were left unchanged in the analysis while units of foreign exchange were multiplied by the SER. Costs and benefits were therefore measured in units of domestic resources which could be called the numeraire of the system.

The methods of LM and SVT leave units of foreign exchange unchanged and adjust the value of domestic resources. They therefore count in units of foreign exchange. A unit of foreign exchange at the official exchange rate is therefore the numeraire of their system. This means that, other than transport and handling cost adjustments, world prices for traded goods can be used as shadow prices unadjusted by the SER. This is why these systems are said to have a world price numeraire.

Standard conversion factor and SER

In the LM and SVT systems the standard conversion factor (SCF) can be defined as the average value of a unit of domestic resources in relation to a unit of foreign exchange. It is the inverse of the SER. In the LM and SVT systems domestic resource costs and benefits (when not further broken down) are multiplied by the SCF. An example in Box 8.10 shows how this might work.

Box 8.10 Example of the use of standard conversion factor

Assume the SER is calculated by the formula which assumes that changes in foreign exchange availability only affect imports. Then using the second formula for SER, and assuming in figures for total imports of $100 million, import duties $25 million then:

$$SER = \frac{(M + T_m)}{M} = \frac{100 + 25}{100} = 1.25$$

If we used a world price numeraire we would not use an SER. Instead we would use an SCF.

$$SCF = \frac{1}{SER} = \frac{1.00}{1.25} = 0.80$$

Suppose that there is a project with one non-traded input and one traded output and investment costs which are entirely imported. At market prices the costs and benefits are:

	Year 0	Year 1-5
Investment Costs	100	
Operating Costs		50
Benefits		100
Net Benefit	-100	+50

Using the method so far outlined we would break down these items:

	Year 0	Year 1-5
F	-100	+100
D		-50

Then we would apply shadow prices:

	Year 0	Year 1-5
F (x 1.25)	-125	+125
D (x 1.00)		-50
Net Benefits	-125	+75

Using a world price numeraire we would have:

	Year 0	Year 1-5
F (x 1.00)	-100	+100
D (x 0.80)		-40
Net Benefits	-100	+60

The measure of costs and benefits is 25% smaller as the numeraire is 25% more valuable.

The Shadow wage conversion factor

The CF for the shadow wage (CF_L) using a world price numeraire is different. For the domestic price numeraire, assuming no transfer costs and that the alternative output of workers has an economic value equal to its domestic market price, then:

$CF_L = m$ where m is the opportunity cost of labour divided by the market price.

Assume m = 0.5

For the world price numeraire:-

$CF_L = ma$ where a is the SCF

$= 0.5 \times 0.8 = 0.4$

The conversion factor for labour is lower using a world price numeraire (25% lower if the SER is 1.25). Sometimes a value for a conversion factor specific to the output of labour is used which may be different from the SCF. This case is equivalent to the case when the alternative output in the domestic price numeraire approach has an economic value different from the domestic market price.

Composite conversion factors

The approach taken so far has been to break down all the costs and benefits of a project into basic resource categories and to apply the shadow prices for these resource categories. This is not the approach taken by LM and SVT. Their approach is to estimate specific conversion factors for each of the cost and benefit items listed in the annual statement at market prices. They also argue that such conversion factors should be available centrally. Some examples of how this may be done are shown in Box 8.11.

Box 8.11 Examples of use of composite conversion factors

a) Traded Good (export)

f.o.b. price	120	x	1.00	=	120
Transport to border	-5	x	0.80	=	-4
Export tax	-15	x	0.00	=	0
Market price	100		Shadow price	=	116

CF = $\frac{116}{100}$ = 1.16

b) Traded Good (import substitution)

c.i.f. price	75	x	1.00	=	75
Import duty	20	x	0.00	=	0
Transport to market	5	x	0.80	=	4
Market price	100		Shadow price	=	79

CF = $\frac{79}{100}$ = 0.79

c) Non-traded good (cost broken down)

Imported inputs	40	x	1.00	=	40
Duties	5	x	0.00	=	0
Skilled labour	10	x	0.80	=	8
Unskilled labour	25	x	0.40	=	10
Other local costs	20	x	0.80	=	16
Market price	100		Shadow price	=	74

CF = $\frac{74}{100}$ = 0.74

Procedures, advantages and disadvantages

The distinguishing features of both the LM and SVT approaches are:

- the world price numeraire; and
- the use of composite conversion factors.

Once the CFs have been calculated the procedure is simply to multiply the market price values for each item by the relevant conversion factor. A new annual statement at shadow prices is then drawn up and discounted at the opportunity cost of capital, also known as the accounting rate of interest (ARI).

The advantages and disadvantages of these approaches are summarised in Box 8.12.

Box 8.12 Advantages and disadvantages of using a world price numeraire

Advantages:

- Once the CFs for different items are known, all that is required is simple multiplication. If the CFs are provided centrally, all the project analyst has to do is the multiplication.
- World prices can be used unadjusted as shadow prices - a rough estimate for a CF is obtained simply by dividing the world price by the market price although, to be strictly correct, account should be taken of local transport and handling costs. The method does not require estimation of an SER although the inverse, the SCF, is required. Some authors contend that, when most inputs and outputs are traded, using the wrong SCF is not as serious as using the wrong SER. From a strictly mathematical point of view, this argument is false since the domestic price and world price numeraire methods give equivalent results.

Disadvantages:

- Central determination of composite CFs means that project analysts can apply shadow pricing without understanding what they are doing. This might be a cause of serious mistakes.
- Composite CFs do not allow ready access to information on distribution effects or the impact on foreign exchange, tax revenue and employment. They also make it difficult to conduct sensitivity analysis on key parameters such as the relative value of foreign exchange and domestic resources.
- Use of the world price numeraire can lead to misunderstanding - particularly the mistaken view that the LM/SVT method necessarily means advocating of free trade.
- It can be argued that the concept of a shadow exchange rate is easier to understand than a standard conversion factor.

Economic analysis using a domestic price numeraire (UNIDO approach)

Use of an SER rather than an SCF implies the use of a domestic price numeraire. Costs and benefits are measure in terms of average domestic prices. The most well known expositions of the domestic price numeraire approach are two publications commissioned by UNIDO - the original 'Guidelines for Project Evaluation' (UNIDO, 1972) followed by a 'Guide to Practical Project Appraisal' (UNIDO, 1978). The latter guide is, in most respects, a condensed version of the 'Guidelines' and this approach is now outlined. Only the differences between the 'Guide' procedures and those already discussed will be dealt with, many of the features are common to both the 'Guide' and the method described in the notes.

The integrated documentation system

The 'Guide' was the first major work on SCBA to pay much attention to the relationship between economic analysis and financial analysis. The Guide uses what it calls an 'integrated documentation system' in which there is a 'Net Cash Flow Real' concerned with resource costs and benefits which is balanced by a 'Net Cash Flow Financial' which shows the financing of the project and the distribution of benefits. Shadow pricing adjustments are made to the resource costs and benefits included in the 'Net Cash Flow Real'. The equality between the two statements is similar to the equality between the Statement of Resource Costs and Benefits and the Statement of the Distribution of Costs and Benefits which was shown in the method described earlier in this section on economic analysis, however the presentation in the 'Guide' becomes rather confusing in later stages of the analysis.

The use of present values

All costs and benefits in the 'Guide' are presented in terms of present values at selected discount rates. Hansen suggests using 0%, 10% and 20% if the discount rate is unknown. Discounting is therefore the first step in the analysis before the application of shadow pricing. This approach, which was also adopted in the original Guidelines, reduces the amount of multiplication in later stages of the analysis at the expense of a lot of discounting in the early stages. It helps to have a micro computer with spreadsheet software including a present value function for discounting when using the 'Guide' approach.

The use of adjustment factors

The 'Guide' approach uses AFs rather than CFs. The value of each adjustment is estimated by multiplying the market price PV of the item concerned by the AF. The total value of each adjustment is obtained by adding up the values of the individual adjustments and then adding the adjustment to the NPV of the 'Net Cash Flow Real' at the previous stage of the analysis.

The use of different stages

The 'Guide' approach works in stages. The first stage is the NPV at market prices after taking account of linkages and externalities.

Stage two of the analysis involves adjusting for 'market price distortions'. Traded goods are valued at border prices thereby eliminating tariffs and other transfer payments. Labour is valued using an opportunity cost shadow wage adjustment.

Stage three involves the shadow exchange rate adjustment. The AF for foreign exchange is applied to the foreign exchange component of each cost and benefit item.

Stages four and five concern 'social analysis' which is not covered by these notes.

The procedure is additive. The final economic NPV of the project is the stage one NPV plus the transfer payment and labour adjustment plus the foreign exchange adjustment.

Switching values and sensitivity analysis

The 'Guide' puts a lot of emphasis on the uncertainty surrounding shadow price estimates and therefore recommends the use of sensitivity analysis for some of the key parameters. In this way switching values can be estimated. The most obvious switching value is the IRR which gives the rate of discount at which the NPV changes from positive to negative.

A second switching value might be the AF for foreign exchange at which the NPV is zero. Calculation of this value gives the domestic resource cost of foreign exchange criterion, sometimes called the Bruno Test (after an economist called Bruno). This test is useful if the discount rate is known and projects are to be ranked according to the efficiency with which they earn foreign exchange. It is also used in the assessment of the competitiveness of different industries and has therefore been used quite widely in formulating specific recommendations for structural adjustment programmes.

Advantages and disadvantages of the UNIDO approach

The main advantages of the UNIDO 'Guide' approach are:

- The approach is flexible and can be taken to whatever degree of complexity is felt advisable.
- The approach shows the link between financial and economic analysis - although the 'integrated documentation system' is not as clear as it might be.
- The procedures are designed to allow easy use of sensitivity analysis where shadow price estimates are uncertain. This may be particularly valuable for economies in a stage of rapid transition.
- The approach can be adjusted to show clearly the income distribution effects of the project as well as the effects on foreign exchange, employment and tax revenue.
- The approach relates more closely to the sort of approximate shadow pricing that have been used in some countries for many years and can be introduced relatively quickly i.e. (rough adjustment of foreign exchange, labour and taxes).

The main disadvantages of the UNIDO 'Guide' approach are:

- The use of present values obscures information on the timing of different effects. The use of present values however is not an essential part of the approach.
- The 'Guide' contains methodological errors. These do not affect the economic analysis and have been resolved in the book by Weiss also published by UNIDO (Practical Appraisal of Industrial Projects).
- The 'Guide' approach has not been so extensively used as the LM/SVT approach and is not backed up by so many published case studies. It is also not used by major

international donor agencies, although its use would probably be acceptable to most of these agencies.

Problems of Economic Analysis

Economic analysis is just a planning tool. Like any tool it should be used for those tasks which it performs best - providing information on the effects of projects on the economy to improve the planning of projects in the context of some form of planning system. It must certainly be adapted to the particular circumstances of the country it is being used in and so, while general approaches and systems have their attractions, they should be sufficiently flexible to allow concentration on the parameters that are important for the country using them. One of the main sources of confusion in the literature on economic and social analysis is the use of different terms to mean the same thing. A list of some of the more important terms, and the letters used to signify them is given in Box 8.13. Other specific problems and criticisms of economic analysis are discussed below.

Partial Analysis

Some economists who believe in the importance of macro-economic planning argue against economic analysis of projects on the grounds that analysis of one project at a time is 'partial'. The implication of this argument is that the whole is greater than the sum of the parts. Economic analysis has a tendency to ignore important linkage effects and the benefits of greater internal integration of the economy. This argument relates to the role of economic analysis in planning systems. If economic analysis of projects were to be seen as a replacement for macro-planning, the argument might have greater force than if economic analysis were seen as part of an iterative planning process. There is now much greater scepticism about the usefulness of forms of macro-economic planning that do not allow for a considerable degree of flexibility.

Complexity of economic analysis

Some people argue that the data requirements and conceptual complexities of economic analysis are too great for practical use in many countries. They imply that the effort involved in undertaking economic analysis would be better spent in other ways. This could simply be regarded as an argument that an economic analysis system should be flexible so as to allow short cuts when there are shortages of planning staff or when projects are too small to justify the cost of an elaborate economic analysis.

World prices

Use of world prices as opportunity costs assumes that such prices can be discovered and that they are sufficiently stable to be used in a medium term project analysis. For many primary commodities, world prices are unstable and difficult to predict, while many capital goods are specific to particular projects and do not have widely known world prices. These problems are forecasting problems and do not invalidate the general approach. However, they do point to the importance of sensitivity analysis and also to the possibility that self sufficiency might be regarded as a goal in itself for reasons of stability. Similarly unstable world prices indicate the desirability of export diversification - the old saying that 'you should not put all your eggs in one basket'.

Box 8.13: Common terms and their equivalents used in economic analysis

Shadow Price	=	Accounting Price
Conversion Factor (CF)	=	Accounting Ratio (AR)
	=	$\frac{\text{Shadow Price}}{\text{Market Price}}$
Premium	=	Conversion Factor - 1
Adjustment Factor (AF)	=	(Conversion Factor - 1) x 100%
Economic Opportunity Cost of Capital	=	Economic Accounting Rate of Interest
	=	q (UNIDO or SVT)
Social Opportunity Cost of Capital	=	Social Accounting Rate of Interest
	=	r (UNIDO) or SARI
Social Discount Rate	=	Consumption Rate of Interest
	=	i (UNIDO) or CRI (LM and SVT)
Shadow Price of Investment	=	Value of Public Income
	=	P^{inv} (UNIDO), s (LM) or v (SVT)
Marginal Rate of Savings	=	s (UNIDO and SVT).
		[No LM equivalent, but sq = LM parameter r.]
Standard Conversion Factor (SCF)	=	$\frac{1}{\text{Shadow Exchange Rate (SER)}}$

LM - Little and Mirrlees approach; SVT - Squire and van der Tak approach

SUMMARY

This chapter has looked at the economic and financial viability of agricultural projects and at some of the methods used in their assessment, in particular resource and cash flow statements, cost benefit analysis, sensitivity analysis and cost effectiveness analysis. While assessing the financial and economic viability of projects is important, they are not always the overriding criteria for approval of all projects. Some projects which appear to have very high potential for economic gain may be risky in terms of the technical, social and institutional factors; or have negative impacts on the environment. While other projects may have significant social and environmental benefits which are difficult to assess in financial and economic terms. Thus in assessing the overall viability of a project it is important to look at all aspects: financial, economic, social and environmental.

EXERCISES

Compounding and discounting

In solving the following exercises you will need a copy of discounting tables and a calculators.

1. Calculate the future value of:

a)	$1	compounded for 10 years at	7% interest per annum
b)	$10	compounded for 5 years at	8% interest per annum
c)	$50	compounded for 15 years at	9% interest per annum
d)	$128	compounded for 8 years at	12% interest per annum

2. Calculate the present value of:

a)	$1	payable in 10 years' time discounted at	6% per annum
b)	$1	payable in 5 years' time discounted at	7% per annum
c)	$1	payable in 15 years' time discounted at	8% per annum
d)	$384	payable in 2 years' time discounted at	12% per annum
e)	10	annual instalments of $10, paid at the year end, discounted at 5% per annum	

3. a) What is the present value of $1000 payable in 26 years' time when the discount rate is 9% per annum?

   b) From the result of part (a), (i.e. without using compounding tables) how would you calculate the future value of $100 compounded at 9% per annum for 26 years?

4. The capital cost of a project is estimated to be $10,000 spread over three years. It is expected that $6,000 will be spent in year 0 and $2,000 in each of the following two years. If the discount rate appropriate to this economy is 8%, what is the present value of the project's capital cost?

5. The benefit of a project are expected to be $100,000 annually for 10 years. What is the present value of this benefit stream? The discount rate is given as 10 per cent.

   What difference will it make if the benefits start to accrue in year 3 instead of year 1 and continue on the same regular basis of $100,000 per annum through to the end of year 8, after which year 9 has no benefits and year 10 has $28,000 from the terminal scrap value of the plant?

NPV and IRR

1. An agricultural public sector project is expected to yield a stream costs and benefits of a life of 8 years as indicated in column (i) when properly maintained, and as in column (ii) when not maintained.

	(i)		(ii)	
Year	Costs	Benefits	Costs	Benefits
0	100	-	100	-
1	40	50	-	50
2	30	50	-	60
3	30	60	-	40
4	20	70	-	30
5	20	120	-	20
6	20	140	-	10
7	20	150	-	10
8	20	150	-	10

(a) Given a discount of 10%, what is the total net present value of the net benefit stream (i)?

(b) Given a discount rate of 10%, what is the total net present value of the benefit stream (ii)

2. Calculate the IRRs of the following cash flows to one point of decimals:

a) When discounted at 6% NPV is - $6,000
When discounted at 5% NPV is + $6,000

b) When discounted at 9% NPV is - $150,000
When discounted at 8% NPV is + $30,000

c) When discounted at 20% NPV is + 440,000
When discounted at 22% NPV is - £600,000

d) When discounted at 6% NPV is + $140,000
When discounted at 5% NPV is + $20,000

3. Consider the following cash flow:

Year	0	1	2	3	4	5
Net Income	-5,500	-200	-400	+1,000	+2,000	+2,500

a) Would you accept this project?
b) What can you say about the IRR?

4. A feeder road would cost Tsh. 40,000,000 and last 10 years. If it were built there would be savings on existing vehicle operating costs of Tsh. 2,000,000 per year. New crops would be grown worth Tsh 20,000,000 per year - but the cost of growing them, transporting them and marketing them would be Tsh 16,000,000 per year.

   a) Calculate the IRR of building the feeder road using a discount rate of 10%.

5. One project option has an NPV of 450 at 5% discount rate, 188 at 10% and -144 at 20%.

   a) Plot these values on a graph with NPV on the vertical axis and discount rates on the horizontal axis using a normal scale. Find the IRR by interpolation.

   b) A second option has NPVs of 1020 at 5%, 300 at 7% and -600 at 10%. Plot these on the same graph. What is the IRR in this case. Which option is the most profitable? How is your choice influenced by the discount rate?