

Benefit-Cost Analysis: Introduction and Overview

Introduction

Social benefit-cost analysis is a process of identifying, measuring and comparing the social benefits and costs of an investment project or program. A program is a series of projects undertaken over a period of time with a particular objective in view. The project or projects in question may be public projects – undertaken by the public sector – or private projects. Both types of projects need to be appraised to determine whether they represent an efficient use of resources. Projects that represent an efficient use of resources from a private viewpoint may involve costs and benefits to a wider range of individuals than their private owners. For example, a private project may pay taxes, provide employment for the otherwise unemployed, and generate pollution. These effects are termed social benefits and costs to distinguish them from the purely private costs and returns of the project. Social benefit-cost analysis is used to appraise private projects from a social viewpoint as well as to appraise public projects.

It should be noted that the technique of social benefit-cost analysis can also be used to analyse the effects of changes in public policies such as the tax/subsidy or regulatory regimes. However a very broad range of issues can arise in this kind of analysis and, for ease of exposition, we adopt the narrower perspective of project analysis in this study.

Public projects are often thought of in terms of the provision of physical capital in the form of infrastructure such as bridges, highways and dams. However there are other less obvious types of physical projects that augment environmental capital stocks and involve activities such as land reclamation, pollution control, fishery management and provision of parks. Other types of projects are those that involve investment in forms of human capital, such as health, education, and skills, and social capital through drug-use and crime prevention, and the reduction of unemployment. There are few, if any, activities of government that are not amenable to appraisal and evaluation by means of social benefit-cost analysis.

Investment involves diverting scarce resources – land, labour and capital – from the production of goods for current consumption to the production of capital goods which will contribute to increasing the flow of consumption goods available in the future. An investment project is a particular allocation of scarce resources in the present which will result in a flow of output in the future: for example, land, labour and capital could be allocated to the construction of a dam which will result in increased electricity output in the future (in reality there are likely to be additional outputs such as irrigation water, recreational opportunities and flood control but we will assume these away for the purposes of the example). The cost of the project is measured as an opportunity cost – the value of the goods and services which would have

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been produced by the land, labour and capital inputs had they not been used to construct the dam. The benefit of the project is measured as the value of the extra electricity produced by the dam. Chapter 2 discusses the concept of investment and investment appraisal in more detail.

The role of the benefit-cost analyst is to provide information to the decision-maker – the official who will appraise or evaluate the project. We use the word “appraise” in a prospective sense, referring to the process of actually deciding whether resources are to be allocated to the project or not. We use the word “evaluate” in a retrospective sense, referring to the process of reviewing the performance of a project or program. Since social benefit-cost analysis is mainly concerned with projects undertaken by the public sector the decision-maker will usually be a senior public servant acting under the direction of a minister. It is important to understand that benefit-cost analysis is intended to inform the existing decision-making process, not to supplant it. The role of the analyst is to supply relevant information about the level and distribution of benefits and costs to the decision-maker, and potentially to contribute to informed public opinion and debate. The decision-maker will take the results of the analysis, together with other information, into account in coming to a decision. The analyst’s role is to provide an objective appraisal or evaluation, and not to adopt an advocacy position either for or against the project.

An investment project makes a difference and the role of benefit-cost analysis is to measure that difference. Two as yet hypothetical states of the world are to be compared – the world **with** the project and the world **without** the project. The decision-maker can be thought of as standing at a node in a decision tree as illustrated in Figure 1.1. There are two alternatives: undertake the project or don’t undertake the project (in reality there are many options, including a number of variants of the project in question, but for the purposes of the example we will assume that there are only two).

The world without the project is not the same as the world before the project; for example, in the absence of a road-building project traffic flows may continue to grow and delays to lengthen, so that the total cost of travel time without the project exceeds the cost before the project. The time saving attributable to the project is the difference between travel time with and without the project, which is larger than the difference between travel time before and after the project.

Which is the better path to choose? The **with-and-without** approach is at the heart of the benefit-cost process and also underlies the important concept of **opportunity cost**. **Without** the project – for example, the dam referred to above – the scarce land, labour and capital would have had alternative uses. For example, they could have been combined to increase the output of food for current consumption. The value of that food, assuming that food production is the best (highest valued) alternative use of the scarce resources, is the opportunity cost of the dam. This concept of opportunity cost is what we mean by “cost” in social benefit-cost analysis. **With** the dam project we give up the opportunity to produce additional food in the present, but when the dam is complete it will result in an increase in the amount of electricity which can be produced in the future. The benefit of the project is the value of this increase in the future supply of electricity over and above what it would have been in the absence of the project. The role of the benefit-cost analyst is to inform the

decision-maker: if the **with** path is chosen additional electricity valued by consumers at \$X will be available; if the **without** path is chosen extra food valued at \$Y will be available. If $X > Y$ the benefits exceed the costs, or, equivalently, the benefit/cost ratio exceeds unity. This creates a presumption in favour of the project although the decision-maker also has to take distributional effects into account – who would receive the benefits and who would bear the costs?

How do we measure the benefit of the additional electricity produced by the project? The gross value of the project output is measured by the amount consumers are willing to pay for it. In the case of a small increase in output **willingness-to-pay** (WTP) is measured by market price. However where the project output is substantial, relative to the original quantity of the good produced and consumed, willingness-to-pay for additional units of the good will be lower than market price because of the downward slope of the demand curve. In these circumstances marginal willingness-to-pay (WTP for an additional unit of output) declines as a result of the project and consumer benefits are measured as an area under the demand curve known as **consumer surplus**.

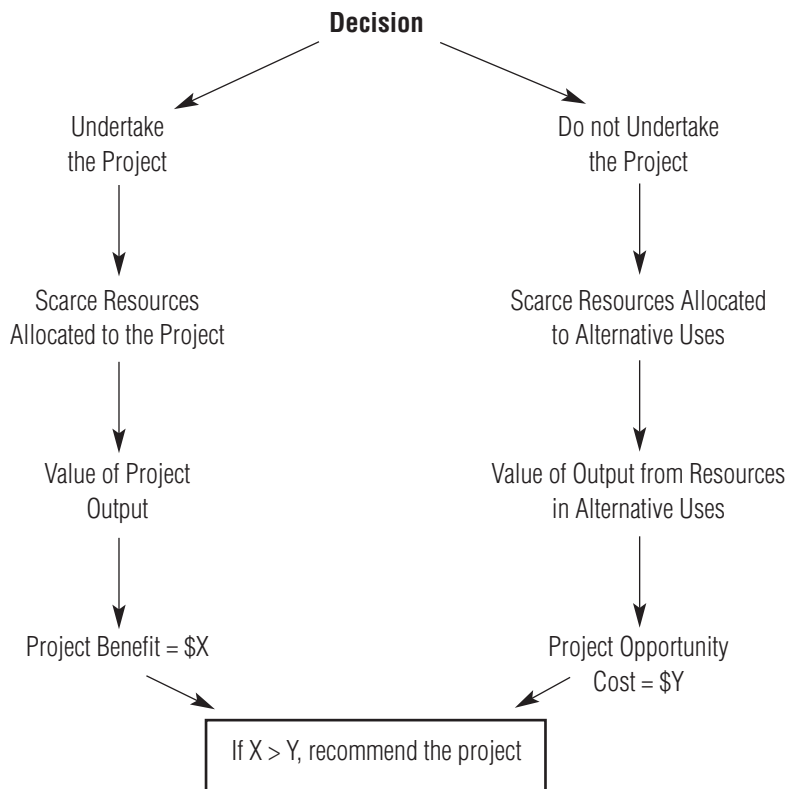


Figure 1.1 The “With and Without” Approach to Benefit-Cost Analysis

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The concepts of consumer surplus, and the corresponding measure of **producer surplus**, which measures benefits or costs to suppliers, are discussed in detail in Chapter 7, in particular the concept of consumer surplus is illustrated by Figure 7.1. We now explain why we defer discussion of these important economic concepts until later in the book.

Traditional expositions of benefit-cost analysis usually start with the notion of consumer and producer surplus. However these concepts are relevant to the analysis only if output or input prices (or, in the case of non-marketed output, imputed prices) change as a result of undertaking the project. In many cases, including the case study which is developed in the Appendices to Chapters 4–6, no price changes can be identified. However all social benefit-cost analyses face the difficult task of social accounting – working out how the overall net benefits (or net costs) of the proposed project will be shared among the interested parties, including foreign and domestic, public and private, and consumers and producers. Entitlement to shares in net benefits is governed by a complex array of fiscal, regulatory and financial arrangements. Failure to understand these relationships can lead to fundamental errors of omission and double-counting in social benefit-cost analysis, and we have given these matters priority in the order of presentation.

The example of the electricity project was presented as if the benefit-cost analysis directly compares the value of extra electricity with the value of the forgone food. In fact the comparison is made indirectly. Suppose that the cost of the land, labour and capital to be used to build the dam is \$Y. We assume that these factors of production could have produced output (not necessarily food) valued at \$Y in some alternative and unspecified uses. We will consider the basis of this assumption in detail in Chapter 5, but for the moment it is sufficient to say that in a competitive and undistorted market the value of additional inputs will be bid up to the level of the value of the additional output they can produce. The net benefit of the dam is given by $\$(X-Y)$ and this represents the extent to which building a dam is a better ($X-Y > 0$) or worse ($X-Y < 0$) use of the land, labour and capital than the alternative use.

When we say that $\$(X-Y) > 0$ indicates a better use of the inputs than the best alternative use we are applying a measure of economic welfare change known as the **Kaldor–Hicks criterion**. The K–H criterion says that, even if some members of society are made worse off as a result of undertaking a project, the project confers a net benefit if the gainers from the project could compensate the losers. In other words, a project does not have to constitute what is termed a **Pareto improvement** (a situation in which at least some people are better off and no one is worse off as a result of undertaking the project) to add to economic welfare, but merely a **potential Pareto improvement**. The logic behind this view is that if society believed that the distributional consequences of undertaking the project were undesirable, the costs and benefits could be redistributed by means of transfer payments of some kind. The problem with this view is that transfers are normally accomplished by means of taxes or charges which distort economic behaviour and impose costs on the economy. The decision-maker may conclude that these costs are too high to warrant an attempt to redistribute benefits and costs. We return to the issue of the distributional effects of projects in Chapter 11.

Since building a dam involves costs in the present and benefits in the future the net benefit stream will be negative for a period of time and then positive, as illustrated in Figure 1.2. To produce a summary measure of the net benefits of the project all values have to be

converted to values at a common point in time, usually the present. The net present value is the measure of the extent to which the dam is a better ($NPV > 0$) or worse ($NPV < 0$) use of scarce resources than the best alternative. Converting net benefit streams, measured as net cash flows, to present values is the subject of Chapters 2 and 3.

When we compute present values for use in a social benefit-cost analysis we need to make a decision about the appropriate rate of discount. The discount rate tells us the rate at which we are willing to give up consumption in the present in exchange for additional consumption in the future. A riskless market rate of interest, such as the government bond rate, provides a measure of the marginal rate of time preference of those individuals participating in the market. However it can be argued that future generations, who will potentially be affected by the project, are not represented in today's markets.

In other words, in using a market rate of interest as the discount rate, the current generation is making decisions about the distribution of consumption flows over time without necessarily consulting the interests of future generations. This raises the question of whether a social discount rate, as opposed to a market rate, should be used to calculate the net present values used in public decision-making. This issue is considered further in Chapters 10 and 11.

Much of what has been said to this point also applies to projects being considered by a private firm: funds that are allocated for one purpose cannot also be used for another purpose, and hence have an opportunity cost. Firms routinely undertake investment analyses using techniques similar to those of social benefit-cost analysis. Indeed the appraisal of a proposed

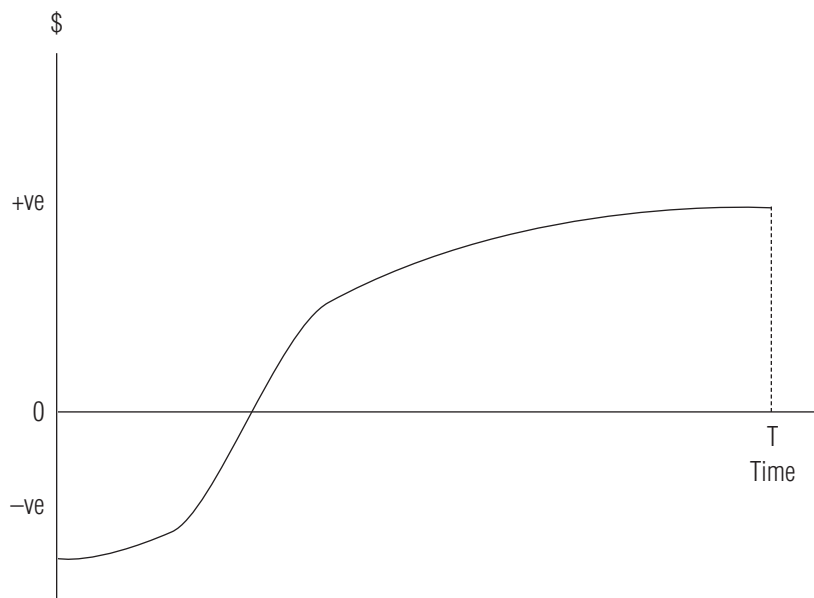


Figure 1.2 Typical Time-Stream of Project Net Benefits

project from a private viewpoint is often an integral part of a social benefit-cost analysis, and for this reason the whole of Chapter 4 is devoted to this topic. A private investment appraisal takes account only of the benefits and costs of the project to the private firm – its effect on revenues and costs and hence on profit. The project may have wider implications – environmental and employment effects, for example – but if these do not affect the firm’s profits – its “bottom line” – they are omitted from the analysis. In contrast a social benefit-cost analysis takes a wider or “social” perspective – it measures and compares the costs and benefits experienced by all members of “society”. In the context of social benefit-cost analysis “society” is to be interpreted in a relatively narrow way: it is simply that group of individuals deemed by the decision-maker to be relevant, and it is usually termed the **referent group**. Before undertaking a social benefit-cost analysis the analyst needs to ascertain from the decision-maker the composition of the referent group. Often the referent group consists of all the residents of a country, but it may be more narrowly defined in terms of sub-groups such as residents of a State or region, or social groupings such as the poor, unemployed, elderly, or people of Aboriginal descent.

It is clear that benefit-cost analysis can be conducted from different viewpoints: for example, it can take account of only the benefits and costs to the owners of the equity (the shareholders) in a private firm; an analysis from this perspective shall be referred to in this book as a **private benefit-cost analysis**. Alternatively, it can be broadened to include all benefits and costs to members of the referent group.

In what we term a **project benefit-cost analysis** estimates of all project benefits and costs are calculated at market prices; the project analysis tells us whether, in the absence of loans and taxes, the project has a positive NPV at market prices. The project NPV calculated in this way is neither the private NPV (the value of the project to private equity holders) nor the social NPV (the value of the project to the referent group). The equity holders do not stand to receive all the benefits of the project or incur all of the costs: for example, taxes may be due on project income, and loans may be obtained to finance part of the project, with consequent outflows in the form of interest payments. Whether the return to equity and debt holders is relevant in a social benefit-cost analysis depends on whether these groups are part of the referent group, but tax revenues paid by the project to the domestic government are certainly social benefits. Furthermore, by pricing inputs and outputs at market prices the project benefit-cost analysis ignores various types of referent group effects such as employment benefits, measured as the project wage bill less the opportunity cost of supplying the labour. It also excludes the benefits or costs of non-marketed commodities such as pollution. We discuss the former type of benefits and costs in detail in Chapter 5, and the latter in Chapter 12.

The important concept of the referent group is illustrated in Figure 1.3, which deals with an example which will be developed in Chapters 4–6 of this book. Suppose that a wholly foreign-owned company proposes to set up a factory in a developing country. The government wishes to appraise the proposal from the point of view of residents of the host country – the referent group. The firm has two questions to consider. First, is the overall project efficient from a market viewpoint? This is determined by the project benefit-cost analysis which compares the benefits and costs associated with undertaking the project, where benefits and costs are calculated at market prices; the present value of the net benefits is represented by

Area A+B in Figure 1.3 (the interpretation of the breakdown of the project net present value into the components A and B will be explained shortly). Second, is the project profitable from the perspective of the firm's owners, or, equity holders? This is determined by the private benefit-cost analysis. If the project is to be wholly internally financed the answer to this second question is obtained by deducting tax payments from the project NPV. However we will assume that there is to be some debt participation in the project in the form of a loan from a financial institution in the host country. The amount of the loan must be deducted from the project cost and the loan repayments and interest charges deducted from the project's after-tax benefits to give the benefits and costs of the project to the equity holders; the private benefit-cost analysis.

In this example we shall assume that the firm's equity holders are not considered part of the referent group. This being so, in Figure 1.3 Area A represents the net present value of the project net benefits to the members of the referent group: the lenders of the firm's loan (the bank) and the recipients of the firm's tax payments (the government). The net benefit of the project to the non-referent group members, the firm's equity holders, expressed as a net present value, is represented by Area B. Only if the net benefit to equity holders is positive is the project worthwhile from the firm's viewpoint. Areas A and B together amount to the project NPV.

As noted above the project may have a wider impact than that summarized by the project benefit-cost analysis. The project may generate benefits or costs to various groups within the host country. For example, some people who would otherwise have been unemployed may obtain jobs: the pay that they receive from the firm may be higher than the value

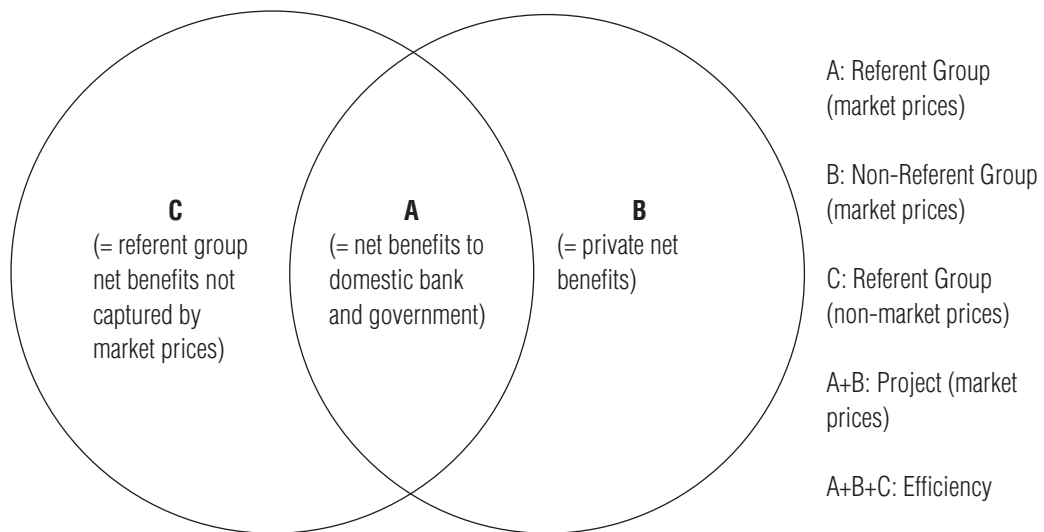


Figure 1.3 Relationship between the Project, Private, Efficiency and Referent Group Net Benefits

of their time in some non-market activity, thereby resulting in a net benefit to them. The firm may purchase various goods and services, such as water and electricity, from government agencies, paying prices in excess of the production costs of these inputs, again generating net benefits for this section of the referent group. The project may generate pollution which imposes health and other costs on residents of the host country. In Figure 1.3 Area C represents the set of net benefits (present value of benefits net of costs) accruing to the referent group as a result of divergences of market prices from referent group valuations of benefits or costs, or as a result of non-marketed benefits and costs. We shall refer to these as **non-marketed net benefits/costs** accruing to members of the referent group. The total referent group net benefit is given by Area A+C.

What then does the whole area, A+B+C, represent? This can be thought of as representing the **efficiency net benefits** of the project – the present value of benefits net of their opportunity cost, and irrespective of whether they accrue to members of the referent group or not. Area B represents the net benefits to the non-referent group equity holders, which will determine the firm's decision whether to undertake the project or not. Area A+C represents the net benefits to the referent group, which will determine the government's decision as to whether or not to allow the project to proceed. Referent group net benefits are a subset of the efficiency net benefits. The composition of the referent group follows from the definition of the scope of the benefits and costs to be counted. As noted earlier, it is essentially a policy decision as to who the relevant stakeholders or referent group members are. The composition of the referent group net benefit is the main issue which the benefit-cost analyst is called upon to address, although in negotiating with the firm the decision-maker may also be interested to know how attractive the project is from a private viewpoint. It should also be noted that the definition of the referent group can be controversial especially in situations where there are transboundary externalities such as pollution affecting citizens of other states or countries.

Apart from measuring the aggregate referent group net benefit, the analyst will also need to know how this is distributed among the different sub-groups as the decision-makers will, most probably, want to take into consideration the distribution of net gains and losses among the referent group members: this is referred to as the **referent group analysis**.

In summary, the hypothetical project discussed above (or any other project) can be appraised from four different points of view:

- (i) the **project** benefit-cost analysis: this is represented by Area A+B and is obtained by valuing all project inputs and outputs at private market prices;
- (ii) the **private** benefit-cost analysis: this is obtained by netting out tax and interest and debt flows from the project appraisal, and, if the firm's equity holders are not part of the referent group as in our example illustrated in Figure 1.3, it will be given by area B: which, in this example, is the non-referent group project net benefit;
- (iii) the **efficiency** benefit-cost analysis: this is represented by Area A+B+C and is obtained in a similar way to the project appraisal, except that the prices used to value inputs or outputs are shadow- or accounting-prices, which are discussed in Chapter 5, or are derived from the application of non-market valuation techniques as discussed in Chapter 12;
- (iv) the **referent group** (or social) benefit-cost analysis: this is represented by Area A+C and can be obtained in two ways as noted below – directly, by enumerating the costs and

benefits experienced by all members of the referent group; or indirectly, by subtracting non-referent group net benefits from the net benefits calculated by the efficiency analysis. In our example, the non-referent group net benefits are summarized by the private appraisal (Area B), although in other cases the private project owners may be part of the referent group.

In the course of undertaking a complete social benefit-cost analysis the project analyst will therefore need to follow a sequence of steps:

- First, calculate the **project** cash flow at market prices (Area A+B in Fig. 1.3)
- Second, calculate the **private** cash flow at market prices (Area B in Fig. 1.3)
- Third, recalculate the **project** cash flow at **efficiency** prices (Area A+B+C)
- Fourth, disaggregate the efficiency cash flow among the **referent group** (and non-referent group) members.

It is clear that there are two ways of going about the task of estimating Area A+C – the net benefits to the referent group: directly, by listing all the benefits and costs to all members of the referent group – in this example, labour, government organizations, and the general public – and measuring and aggregating them; or indirectly by measuring the efficiency net benefits of the project and subtracting from them the net benefits which do not accrue to the referent group. Under the first approach Area A+C is measured directly; under the second approach Area A+B+C is measured and the net benefits to those not in the referent group (represented in the example by Area B) are subtracted to give Area A+C.

At first sight it might seem strange to consider using the indirect approach. However as we will see in Chapters 4 and 5 it is relatively easy to measure the net benefits represented by areas A+B+C and B respectively. The net efficiency benefits of the project are obtained by valuing all project inputs and outputs at marginal values to the world economy: these marginal values may be represented by accounting- or shadow-prices which are artificial rather than observed market prices, and which are relatively easy to calculate, as discussed in Chapter 5, or by prices obtained from the application of non-market valuation techniques as discussed in Chapter 12. The net private benefits are obtained by using market prices which are directly observable, and deducting tax and debt flows: this calculation simply mimics the process which the firm undertakes internally to decide whether or not to proceed with the project. Measuring Area A+C directly is more difficult because each subset of the referent group which is affected by the project has to be identified and their costs and benefits measured. In summary, the indirect approach produces an aggregate measure, whereas under the direct approach the social net benefits are measured in disaggregated form and assigned to various groups. While the disaggregation provides important information which relates to the income distributional concerns of the decision-maker it is more difficult to obtain than the summary figure.

In this book we advocate the use of both approaches: measure Area A+C as A+B+C less B, and then measure its component parts directly and sum them to get Area A+C. If the same answer is not obtained in both cases an error has been made – some benefits or costs to members of the referent group have been omitted or incorrectly measured. A check of this nature on the internal consistency of the analysis is invaluable.

An analogy which may assist in determining what is to be measured and where it belongs in the analysis is to think of the project as a bucket. Costs go into the bucket and benefits

come out: however the range of benefits or costs which go in or come out depends on the perspective that is taken. In the **efficiency analysis** we count all the costs and benefits measured at the appropriate shadow-prices, and the latter minus the former – the net benefits of the project – is equivalent to Area A+B+C in Figure 1.3. The **project analysis** is similar to the efficiency analysis except that all the costs and benefits are measured at market prices, where these exist, to obtain an estimate of Area A+B, and non-marketed benefits and costs are ignored. In the **private analysis**, which, in the example, measures non-referent group net benefits accruing to the foreign firm, we count all sums contributed or received by the firm's equity holders to calculate the non-referent group net benefits (Area B). In the example this consists of the project cost less the loan obtained from the domestic bank, and the project revenues less the interest and principal repayments, and the tax payments to the host country. In the **referent group** analysis we count all contributions and receipts by referent group members to estimate Area A+C: in our example this consists of Area A – the capital contribution of the domestic financial institution, together with the loan repayments and interest payments, and the taxes received by government, and Area C – the employment benefits received by domestic labour. (If there are other, non-marketed net benefits or costs accruing to *non-referent group* members, we would need to add this as an additional category, say D, which would be included in the efficiency benefit-cost analysis, but, like area B, deducted from the aggregate efficiency net benefit to arrive at the total referent group net benefit. This is considered in more detail in Chapter 6.)

At this point it should be stressed that many projects will not correspond exactly to the above example, and what is to be included in Areas A, B and C will vary from case to case. Furthermore, additional categories of project effects may be required. For example, suppose, as in the case study developed in the appendices to Chapters 4–6, that part of the cost of the project was met by a loan from a foreign bank which is not part of the referent group. To incorporate this possibility we would add the foreign bank's net benefits to Area B in Figure 1.3. Area B still forms part of the efficiency benefit-cost analysis but this area has to be subtracted from the total efficiency NPV to calculate the referent group NPV. Another possibility is that instead of paying taxes the foreign firm receives a subsidy. Areas A and B would then need to take account of the subsidy: as a credit item in Area B and a debit item in Area A. A comprehensive framework which takes account of all possible categories of benefits and costs is presented in Chapter 6.

We have discussed four ways of looking at a benefit-cost analysis, and the inter-relationships among these four points of view. The client for whom we are conducting the analysis will rarely attach equal importance to each. For example, an international organization such as the IMF or World Bank may be primarily interested in the best use of scarce resources, as summarized by the efficiency analysis. A regional organization, such as a regional development bank, will also be interested in efficiency but will want to know how the host country – the referent group – is affected. The host country will be primarily concerned with referent group effects but, where a private firm is involved, may also be concerned with the viability of the project from a private viewpoint for negotiation purposes. The private firm will similarly be interested in the referent group analysis as it tries to obtain favourable terms from the host country.

The Use of Spreadsheets in Social Benefit-Cost Analysis

An important theme of this book is the use of spreadsheets in benefit-cost analysis. This theme is developed in detail in Chapters 3–6. However, since the structure of the spreadsheet directly reflects the various points of view accommodated in the social benefit-cost analysis, it is instructive to consider the layout of the spreadsheet at this point.

The spreadsheet is developed in five parts in the following order:

- (i) a data section containing all relevant information about the project – costs, outputs, prices, tax rates etc. This is the only part of the spreadsheet which contains the raw data pertaining to the project. All the entries in the remaining four parts of the spreadsheet consist of references to the data in this first section;
- (ii) a section containing the **project** benefit-cost analysis;
- (iii) a section containing the **private** benefit-cost analysis;
- (iv) a section containing the **efficiency** benefit-cost analysis;
- (v) a section containing the **referent group** benefit-cost analysis.

The relationships among these sections can be illustrated by means of the following simple example. Suppose that a foreign company proposed to invest \$100 in a project which will produce 10 gadgets per year for a period of 5 years. The gadgets will sell for \$10 each. To produce the gadgets the firm will have to hire 20 units of labour per year at a wage of \$3 per unit. The project is located in an area of high unemployment and the opportunity cost of labour is estimated to be \$2 per unit. The firm will pay tax at a rate of 25% on its operating profit (defined here as its total revenue less its labour costs). There are no other costs or allowances, such as depreciation allowances, and the project has no effect on the market price of any input or output.

Figure 1.4 illustrates the structure of the spreadsheet. The project data, consisting of the capital cost, the output and input flows, the prices and shadow-prices, and the tax rate are entered in Section 1. In Section 2 the project benefit-cost analysis is conducted: the flows of costs and benefits, valued at market prices, are calculated for each of the five years of the project's life, using Section 1 as the source of the data. A net benefit stream, represented by a net cash flow, summarizes the effects of the project, and net present values at a range of discount rates, and an internal rate of return are calculated. In Section 3, the private benefit-cost analysis is conducted, again with reference to the data in Section 1. In this simple example, the benefits of the project to the private firm consist of the after-tax returns. Again the performance of the project is summarized in the form of a net cash flow, and net present values and the internal rate of return are calculated. In Section 4 the efficiency benefit-cost analysis is conducted which involves using shadow-prices where appropriate. In the simple example, the only shadow-price required is that of labour, which is \$2 per unit. As in Sections 2 and 3 of the spreadsheet the net benefit stream is calculated from the data in Section 1 and expressed in the form of a net cash flow. Net present value is calculated for the chosen range of discount rates and an internal rate of return is calculated.

Section 5 contains the referent group benefit-cost analysis. In this case it is assumed that the referent group consists of the government and workers of the host country, and does not include the foreign equity holders of the private firm. The first line of the referent group

Section 1: Project Data					
Capital Cost	\$100	Product Price	\$10	Tax Rate	25%
Output Flow	10	Wage	\$3	Dis. Rate	5%
Labour Input	20	Shadow Wage	\$2	Discount	10%

		Year				
	0	1	2	3	4	5
Section 2: Project Cost-Benefit Analysis						
Benefits		100	100	100	100	100
Operating Costs		20	20	20	20	20
Capital Cost=	-100					
Net Benefit	-100	40	40	40	40	40
NPV@5%	= \$73.15	NPV@10%	= \$51.63	IRR = 29%		
Section 3: Private Cost-Benefit Analysis						
Benefits		100	100	100	100	100
Operating Costs		20	20	20	20	20
Capital Cost=	-100					
Taxes		-10	-10	-10	-10	-10
Net Benefit	-100	20	20	20	20	20
NPV@5%	= \$29.85	NPV@10%	= \$-3.72	IRR = 15%		
Section 4: Efficiency Cost-Benefit Analysis						
Benefits		100	100	100	100	100
Operating Costs		40	40	40	40	40
Capital Cost=	-100					
Net Benefit	-100	20	20	20	20	20
NPV@5%	= \$159.77	NPV@10%	= \$-27.45	IRR = 53%		
Section 5: Referent Group Cost-Benefit Analysis						
Referent Group Aggregate Net Benefits						
	0	20	20	20	20	20
Referent Group Net Benefit Allocation						
Govt (Taxes)		10	10	10	10	10
Labour (rent)		20	20	20	20	20
Total		20	20	20	20	20
Net Present Values		5%	10%			
Govt		\$41.72	\$17.97			
Labour		\$20.52	\$75.82			
Total		\$129.58	\$113.72			

Enter values for all project variables in "Project Data" table

Set up *Project Cash Flow* drawing on data in Section 1 (A+B in Fig. 1.3)

Derive *Private Cash Flow* by adding taxes to project costs (B in Fig. 1.3)

Derive *Efficiency Cash Flow* using shadow wage (A+B+C in Fig. 1.3)

Allocate *Referent Group Net Benefits* to referent groups, "Government" and "Labour"

Figure 1.4 The Benefit-Cost Analysis Spreadsheet

analysis is simply the difference between the efficiency net benefit stream and the private net benefit stream. While this calculation gives us the aggregate net benefits to the referent group, we want some information about the distribution of these benefits. The two groups of beneficiaries are the government and labour and we enter the net benefit streams accruing to each: tax revenues to government, and rent to labour – wages in excess of those which could be earned in the alternative activity. When these two benefit streams are added we get an alternative measure of the referent group net benefit stream.

If the referent group net benefit measures obtained by the two methods of calculation are inconsistent in any year, an error has occurred, perhaps in shadow-pricing or in identifying or measuring benefits or costs to referent group members. Once any discrepancy has been accounted for and corrected, summary measures of the performance of the project from the viewpoint of the referent group can be prepared. In this case net present values only are presented because the referent group net benefit stream does not have an internal rate of return, for reasons discussed in Chapter 2.

In summary, we have developed a template for conducting a social benefit-cost analysis, using a spreadsheet, which contains an internal check for accuracy. Because project data are entered in Section 1 only, we can use our model to perform sensitivity analyses simply by changing one cell entry in the data Section. For example, suppose the tax rate were increased to 40%, would there still be sufficient inducement to the foreign firm to proceed with the investment, while providing a reasonable net benefit stream to the referent group? To answer this question, all we need do is change the tax rate cell in Section 1 to 40% and review the new set of results.

The Rationale for Public Projects

It was suggested above that a set of accounting-prices (usually termed shadow-prices), or a set of prices obtained by use of non-market valuation techniques was required to calculate the efficiency net benefit stream of the proposed project. This raises the question of what is wrong with market prices, or why markets do not exist for some commodities which affect economic welfare, and indirectly raises the issue of the rationale for public projects – and social benefit-cost analysis.

It would be appropriate to use market prices to calculate the efficiency net benefit stream of a project if these prices measured the benefits (opportunity costs) of all project outputs (inputs). This condition would be satisfied if markets were competitive (in the sense that no market participant can have any individual influence on price), undistorted (by taxes and public regulation, for example) and complete (in the sense that everything that contributes to economic welfare is traded in a market). If we lived in such a world, market prices would accurately measure social benefits and costs, and since participants in markets are assumed to be utility or profit maximizers, every scarce input would be allocated to its highest value use. The economy would be working efficiently in the sense that no reallocation of scarce resources could make anyone better off without making someone else worse off to a greater degree.

What then would be the role of the public sector? While governments might be concerned

with the fairness of the income distribution generated by the market economy the argument that public intervention, either in the form of undertaking projects or requiring modifications to proposed private projects, could lead to a more efficient allocation of resources would be unsustainable. In other words, if markets are perfect and the existing distribution of income is deemed optimal, there is no need for public projects, social benefit-cost analysis, and social benefit-cost analysts!

In fact, as discussed in detail in Chapter 5, in most economies markets are non-competitive, distorted and incomplete to a greater or lesser degree. Even the so-called “free market economies” are rife with market imperfections – budding social benefit-cost analysts can breathe a sigh of relief! Proposed private sector projects are not necessarily in the public interest, and projects which are in the public interest will not necessarily be undertaken by the private sector and will require government involvement. However market imperfections constitute a double-edged sword: because some markets are imperfect to a significant degree we cannot trust the prices they generate to accurately measure the efficiency benefits and costs of a proposed project. This means that for the purpose of undertaking a project appraisal, the analyst needs to modify observed market prices in various ways to ensure that they reflect efficiency values, or, in cases in which the market does not exist, to generate them in other ways. It should be stressed that these modifications are for the purpose of the social benefit-cost analysis only: the accounting- or shadow-prices are not actually used to pay for project costs or charge for project benefits.

It was suggested above that even if the market economy succeeded in achieving a completely efficient allocation of resources there might still be a case for government intervention on income distributional grounds. Recalling that the decision-maker is a public servant acting under the instructions of a minister – an elected politician – it should come as no surprise that the income distributional effects of a public project – who benefits and who loses – will be an important consideration in determining whether or not the project should proceed. In Chapter 11 we outline some approaches to evaluating the income distributional effects of public projects. However we consider the social benefit-cost analyst’s primary role to be identifying, measuring and evaluating the efficiency effects of the project – in particular, do the gains to the referent group outweigh the losses irrespective of who the gainers and losers are? – and to identifying and measuring, but not evaluating, the income distributional effects of the project. The former role is fulfilled by means of the aggregated approach to measuring the social net benefits of a project, whereas the latter role requires the disaggregated approach to referent group net benefit measurement described earlier.

The social benefit-cost analysis should identify sub-groups among the referent group who are significantly affected by the project – for example, a proposed new airport will benefit air travellers but will inflict costs on residents in the vicinity of the proposed site. The analyst needs to identify the nature of these effects – reduced travel time for passengers, and increased noise for residents – to measure them in physical units – hours saved, additional decibels endured – and to quantify them in dollar terms as far as possible. The role of the decision-maker is then to determine whether X dollars worth of gain for one group justifies Y dollars worth of pain for another.

The Role of the Analyst

To this point we have described the analyst's role as if she was a passive actor in the benefit-cost process – called in to provide information about a particular proposal and then dismissed once the report has been submitted. This view neglects a very important function of the analyst – that of project design – a function which emerges during the process of scoping the analysis. Suppose that the analyst is contacted by the Department of Agriculture: “We are considering building a 30 metre dam at the end of Headless Valley to provide irrigation water to farmers. We would like you to do a benefit-cost analysis.” At the first meeting with Department officials the analyst needs to ask: why a 30 metre dam? Why Headless Valley and not somewhere else? Why is the dam not also producing electricity? What provisions have been made for recreational access? And so on. In the process of this meeting it may emerge that all these questions have been carefully considered and that in fact the proposed project design is the best option. However often it turns out that in the process of determining exactly what is to be appraised the analyst is able to assist the Department officials in clarifying their objectives and refining their proposal. In other words, benefit-cost analysis is not limited to a linear process of project design, from appraisal to implementation, but can be a feedback process as illustrated in Figure 1.5.

Project evaluation – the retrospective assessment of project benefits and costs – may also play a part in this process by providing valuable information about the appropriate design of

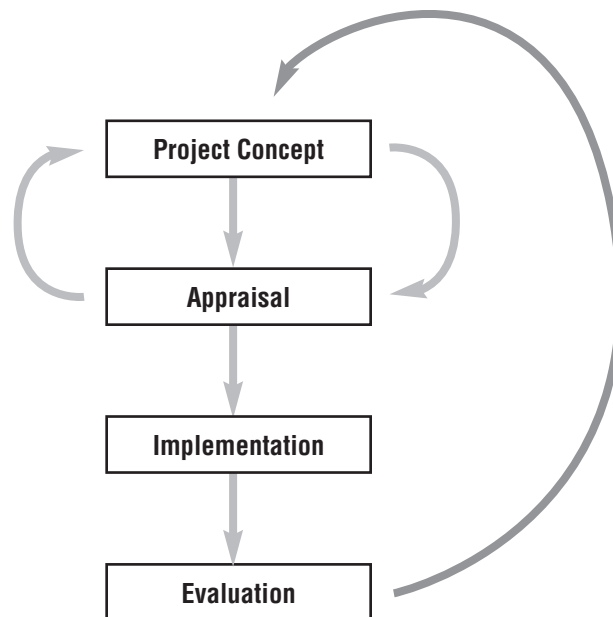


Figure 1.5 Project Appraisal and Evaluation as a Continuous Process

future projects. However, it is worth noting that government agencies seldom commission retrospective project evaluations, suggesting that governments are more inclined to use benefit-cost analysis as a tool to support current decisions than for assessing their performance in implementing past decisions.

It has been suggested that the analyst may be able to help the client formulate a better proposal – one which has a higher net present value to the referent group than the original proposal – although this does not guarantee that the revised project can be recommended on efficiency grounds. However the analyst may also be able to assist with the income distributional aspects of the project: these are sometimes difficult to identify and may emerge only during the drafting of the report. At this stage the analyst may be in a position to suggest measures which may offset the losses which some sub-groups would experience if the proposal went ahead. For example, Headless Valley may be a prime area for wild-life viewing and bird-watching. Is there an alternative area which could be developed as a substitute? This would reduce the net loss suffered by the nature viewing group and make the project more “fair” in terms of its distributional effects. It might incidentally, and of interest to the politician, reduce the level of political opposition to the proposed project.

Further Reading

Most introductory- or intermediate-level microeconomics texts contain sections devoted to the three main economic issues arising in this Chapter: the notion of scarcity and opportunity cost; how to identify a change in the level of economic welfare; and the failure of markets to allocate resources efficiently. The latter two issues are the main topic of welfare economics, about which many books have been written, some of which are quite technical. An advanced text with a focus on practical issues is R. E. Just, D. L. Hueth and A. Schmitz, *Applied Welfare Economics and Public Policy* (Prentice Hall, 1982). See also A. E. Boardman, D. H. Greenberg, A. R. Vining, and D. L. Weimer, *Cost-Benefit Analysis: Concepts and Practice* (Prentice Hall, 2001) Chs. 1 and 2.

Exercises

1. The Casino has given you \$100 worth of complimentary chips which must be wagered this evening. There are two tables – roulette and blackjack. The expected value of \$100 bet on roulette is \$83, and the expected value of \$100 bet on blackjack is \$86. What is:
 - (i) the opportunity cost of betting the chips on roulette?
 - (ii) the opportunity cost of betting the chips on blackjack?

2. Suppose you have been offered a choice of two part-time jobs: 10 hours a week stacking shelves at the supermarket for \$10 an hour; or 12 hours a week working in the bar of the local hotel for \$8 per hour plus a free case of beer once a week. Assuming that you will take one and only one of the jobs, what is:
 - (i) the opportunity cost of taking the supermarket job?
 - (ii) the opportunity cost of taking the hotel job?

3. A foreign firm is considering a project which has present values of benefits and costs, at market prices, of \$100 and \$60 respectively. If the project goes ahead, tax of \$20 will be paid to the host country, and pollution costing the host country \$10 will occur. Assuming that the owners of the foreign firm are not part of the referent group, what are the net present values generated by:
- the project benefit-cost analysis;
 - the private benefit-cost analysis;
 - the efficiency benefit-cost analysis;
 - the referent group benefit-cost analysis?
4. Suppose that the economy consists of three individuals, A, B, and C, and that there are three projects being considered. The net benefits, measured in dollars, received by the three individuals from each of the three projects are reported in the following Table:

Individual	Project		
	1	2	3
A	-10	+20	+5
B	+5	+1	-5
C	+10	+1	-1

Which of the projects, if any, can be described as follows:

- a Pareto improvement
- a potential (though not an actual) Pareto improvement
- neither a potential nor an actual Pareto improvement.