COST-BENEFIT ANALYSIS AND ECONOMIC VALUATION METHODS

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INTRODUCTION

Cost-benefit analysis (CBA) is perhaps the best known technique for public policy analysis and is widely used by policy makers. CBA is a method of evaluating the alternative options in a consistent and comprehensive manner. The basic principle of CBA can be stated simply: if the benefits exceed its costs, then the proposal is worth proceeding with, but if costs exceed benefits the proposal is rejected.

There are three main elements in CBA.. The first involves the identification of the potential benefits and costs. Here, we need to identify the increase in benefits which are the result of the proposal, and the reduction in the supply of inputs (costs) available to the rest of the economy which can be attributed to the proposal's existence. The benefits and costs are identified, therefore, as the differences in availability of outputs and inputs with and without the proposal. The second stage involves the valuation of the identified costs and benefits in terms of a common yardstick, so that the various outputs and inputs can be added together to give an aggregate valuation of total benefits and total costs. Third allowance is made for the fact that the benefits and costs are spread over a period of time. Benefits and costs that occur some time in the future are less valuable than those that accrue in the present, and the procedure of discounting is used to convert impacts accruing in different time periods into equivalent values that can be added together.

FINANCIAL APPRAISAL

In financial appraisal the benefits are given by the revenue receipts from the sale of the project outputs and the inputs are given by the costs (expenditures) of production. Market prices are therefore used as the unit of valuation.

The first step in the financial appraisal is to calculate the project's cash flow. This is done by recording on an annual basis the revenues and expenditures for the entire life of the project. The difference between the yearly receipts and expenditures is the net cash flow. Cash received in the future is less valuable than cash received immediately. The reason for this is simply that money received in the future rather than the present represents an opportunity cost, in terms of the income that could have been earned by investing the funds in an interest-bearing account or revenue-earning productive activity. This is why borrowers have to compensate lenders for the income they are forgoing, by paying a rate of interest. The rate of interest therefore reflects peoples' preference for money in the future; i.e. it represents individuals' 'rate of time preference'.

In order to combine each year's net cash flow into a single aggregate figure, we need to convert them into equivalent terms. This is done by the process of discounting, which converts future values into an equivalent present period value. We can explain this important process by using a simple example. Suppose a firm or individual is asked to choose between $100 today and $100 next year. The choice will be in favour of $100 today, which can then be placed in a savings account, earning, say, 10 per cent a year. After one year the interest payment will have increased the savings account balance to $110. So the prospect of $100 a year from now is equivalent to only $100 divided by 1. 1 = $90.9 in present period terms. This process of reducing future values to their present period equivalent value is called discounting. If the example is extended to a second year, then we need to allow for the fact that interest will be earned on the previous period's interest, increasing the savings balance to $121 ($110 + $11).

The payment of $100 two years hence would therefore be discounted to give a present value of $100 divided by 1.21 = $82.6. A general expression for calculating the net present value (NPV) is

$$NPV = \sum_{t=0}^{n} \frac{Bt - Ct}{(1+i)t}$$

where Bt and Ct are the benefits (revenues) and costs (expenditures) in each year t, I is the discount rate (rate of interest) and n is the life of the project. The calculation of NPV can be easily undertaken using discount tables.

The NPV criterion follows directly from what has already been discussed, namely that a project is worth proceeding with if its NPV is positive.

Box 1: Discounting and Calculation of Net Present Value

Suppose the proposal is expected to give annual benefits for 5 years of $ 600. The annual costs are $350. The discount rate is 10%.

Year	0	1	2	3	4
Benefits	500	500	500	500	500
Costs	350	350	350	350	350
Net Benefits	150	150	150	150	150
Discount Factor (for 10%)	1.0	0.909	0.826	0.751	0.683
Discounted Net Present Value	150	136.35	123.9	112.65	102.45

The total net present value = 150 + 136.35 + 123.9 + 112.65 + 102.45 = 625.35

ECONOMIC PROJECT APPRAISAL

Welfare economics shows that a perfectly competitive market economy will generate a welfare-maximizing use of the nation's resources, where market prices of outputs and inputs are everywhere equal to marginal opportunity cost'. Therefore, if markets were perfectly competitive, they would produce an economic-efficiency outcome, and financial and economic project appraisal would be identical. But we know that perfectly competitive markets seldom, if ever, exist in the real world. Hence the need to undertake an economic appraisal using shadow prices instead of market prices to value the project's benefits and costs.

There are two main sets of factors which cause market prices to diverge from shadow (efficiency) prices. The first is market imperfections or 'failures', and the second is market 'distortions'. Market failures relate to situations where markets for particular goods and services fail. to meet the conditions of perfect competition. There are two main categories of market failure where shadow prices will be required - imperfect competition and externalities. Most markets are characterized by a degree of imperfect competition, which means that the market price will exceed the marginal cost of production. Natural monopolies occur when major economics of scale exist in the provision of the goods or services and prevent a free market which would provide an economically efficient outcome. In other instances, the competitive market may be prevented from emerging by collusion among a small number of major producers to prevent other firms from entering the market. Externalities occur when an economic activity has an impact on someone other than the consumer or producer. Environmental damage is one common type of external cost. On the benefit side, training and human capital improvements are often cited as examples where the market undervalues the output being produced. A project may also give rise to external effects which occur through price changes. Those pecuniary

externalities may also need to be included in the economic appraisal. Forward linkage effects can occur in the industries that use the project's output and backward linkage effects in industries that supply its inputs if these industries are stimulated by increased demand and higher prices for their outputs or lower prices for their inputs. On the other hand, the project may cause other competing producers to lose market share, and other users of inputs to pay higher prices.

Market distortions relate to situations where market values for particular goods or services diverge from their efficiency values as a result of government intervention in the market in question. Government policies affecting foreign trade are frequently the cause of distortions. For example, the use of tariffs and other non-tariff controls on imports tend to increase the domestic market price of imports and import-substitutes above their 'border' (i.e. cost, insurance and freight (cif)) price. This increase in domestic prices relative to world prices in turn often loads to the maintenance of an overvalued exchange rate, another form of market distortion. Policies directed towards domestic factors of production or outputs can also create 'distorted' (i.e. non-efficient) market prices. For example, minimum wage legislation may result in a market wage rate which is greater than the efficiency (marginal opportunity cost) price of labour. Similarly, controls on interest rates, and on the prices of outputs produced by public enterprises, can cause the market prices to diverge from their efficiency values. Box 1 illustrates the main factors giving rise to differences between economic and financial prices.

Box 1: Factors Associated with the Difference between Economic and Financial Prices

Consumer surplus: market prices reflect prevailing average prices, e.g. £1 for a bus ticket. Some consumers would be willing to pay more (perhaps £1.2). The difference between willingness to pay and actual price paid is called, consumer surplus. Hence, the use of market prices can undervalue consumption and related benefits especially where these are so called 'free' or 'public goods' available at zero price.

Transfer payments: some market prices contain elements that do not involve the use of real resources but are mechanisms for transferring revenue between different groups. Value-added tax on consumer prices and grants and subsidies paid to producers, are obvious examples. Less obvious are the interest charges made by the owners of capital, or rents charged by the owners of land (excluding buildings). These, it is argued, do not constitute real costs, only transfers.

Market imperfections and intervention: in theory, market prices should reflect the unrestrained interaction of demand for and supply of commodities where demand reflects consumers' willingness to pay and supply reflects the real costs incurred by producers. In practice, the conditions for markets to work well are not always in place, if only because adequate market information is lacking. In the extreme, Monopolists (sole suppliers) and monopolists (sole purchasers) can intervene or adopt restrictive practices in order to control market throughput and prices to suit themselves. Similarly, Governments may intervene to regulate markets for a variety of reasons, including those of ensuring cheap food to urban populations, or protecting infant industry.

Foreign exchange rates: Until very recently, many Governments operated fixed exchange rates with foreign exchange rationed through the central bank. These rates often overvalued local currency in terms of hard currency (US$) equivalent and had the effect of making imports cheap and exports expensive. The demand for foreign exchange at the official rate far exceeded supply, encouraging the growth of unofficial, black markets with rates which reflected the opportunity cost of hard currency. Valuing internationally traded commodities at these latter ''shadow' rates gave better indicators of real resource costs. More recently, as part of IMF structural adjustment packages, many countries have removed exchange controls. This has led to currency devaluation and exchange rates which better reflect the real value of foreign exchange.

International border prices: In some countries, domestic prices for commodities such as wheat or energy are artificially set by Government such that the import or export world market price is regarded as a better indicator of the value of a commodity or resource.

Under-utilised resources: market prices may overstate the real opportunity cost of new use. Land used in a development project has no real cost if it otherwise remains unused, even though a purchase price or a rent has to be paid. If surplus resources exists in the economy, such as idle land, resources used up in a project, by a road for instance, can be replaced from the existing stock without output loss. In such a case, land resource costs are zero, but there may be some additional costs associated with the relocation of economic activities, such as those associated with greater transport distances, reconstruction of facilities, or land improvement. Compensation payments to resettled population are likely to reflect additional costs to those who relocate, but are not always a reliable estimate of real resource costs.

Similarly, where there is high labour unemployment market wage rates may overestimate the real economic cost (the shadow wage rate) of employing labour which otherwise would be idle or under-employed.

Payments are sometimes made to compensate for environmental loss borne by a community as a consequence of a project. These Payments may take the form of expenditure by the project on new community infrastructure and services. They are sometimes referred to as 'planning gain', though in practice they are usually to compensate for 'planning loss'.

Unpriced Non-traded Items: in some instances, there may be no market and therefore no price for some goods and services. Unpaid, non traded, family labour, is an example. This characteristic also applies to many environmental qualities which are often regarded as 'free', unpriced goods which do not command a market price. They nevertheless have a value in that a change in environmental quality can have significant welfare and hence economic impacts. Economic analysis tries to derive values or prices which reflect real opportunity costs values.

Source: J. Morris, Notes on CBA.

So far we have identified the various factors which make market values inappropriate measures of efficiency values, and which therefore necessitate the use of shadow prices in undertaking economic project appraisal. How then are the shadow prices, which will be substituted for market prices in the economic appraisal, to be calculated?

VALUATION TECHNIQUES

There is a range of valuation techniques that can be used to estimate shadow prices. The choice of technique will depend on the particular impact under consideration and on the availability of data. In some instances, it may be possible to apply several techniques to the valuation of the impact, which can provide a useful cross-check on the reliability of the estimates obtained. Many 'missing' market values occur in the environmental benefits and costs, and the remainder of this section discusses the use of different shadow price valuation techniques in relation to the environment.

In all cases, the underlying approach is the same - to estimate what individuals would be willing to pay (or willing to accept in compensation) for a specified change in an environmental good or service. There are three main ways of calculating these values:

1. Using market prices.
2. Using information on individuals' preferences.
3. Benefit transfer.

1. Valuation using market prices

- *Change in productivity* This method values environmental change by observing physical changes in the environment and estimating what difference they will make to the value of marketed goods and services. This approach is applicable in calculating direct and indirect use value. Water pollution can reduce fish catches, and air pollution can affect the growth of crops. In both instances, the environmental impact reduces marketed output, which may be valued using market prices.

Box 2: Example of change in productivity method: Coastal Forest Protection Project, Croatia

Reforestation activities were estimated to result in increased wood production, which would be harvested at various intervals in the future. Using estimates of increased output (in terms of quantity and quality) and expected price at the time of harvest, it was possible to calculate the economic value of the increased wood production.

- *Human capital cost valuation* This method may be used to value the impact of environmental hazards on human health. Environmental 'bads' such as air and water pollution or the use of pesticides reduce the quality of the human capital stock, and therefore lower the economy's productive capacity. To apply the human capital cost method it is first necessary to determine the relation between the hazard and human health, by expressing the health impact in terms of premature death, sickness or absenteeism. Sickness can then be valued using medical and health care costs. Absenteeism is valued in terms of lost earnings (this assumes that earnings measure the contribution that the absent worker would have made to output).

Box 3. Example of Human Capital Cost Method: Air Pollution Costs in Mexico City

A 1991 World Bank study used the cost-of-illness approach to estimate air pollution costs. The study used a three step procedure:

determining the ambient concentrations of various pollutants;

using dose-response relationships to determine the incremental incidence of disease including both morbidity and mortality in the population;

estimating the costs of the increase in morbidity and mortality, as measured by treatment costs, loss of wages and loss of lifetime earnings.

2. Valuation using information on individuals' preferences

Often it will not be possible to link the environmental impact to a change in marketable output. In these cases, the willingness to pay has to be estimated indirectly, using a range of other techniques, such as:

- *Replacement cost or preventive expenditure method* The economic value that individuals attach to the environment can sometimes be inferred from the cost of preventing unwanted environmental impacts, or of restoring an asset to its original state after it has been damaged. For example, the costs of air pollution-related acid depositions could be estimated using the costs of restoring damaged physical infrastructure, or the costs of soil erosion could be estimated using the costs of providing preventive terracing.

Box 4: Example of replacement cost and preventative expenditure Method: Flood Control and Soil Conservation Project,

Yellow River Basin, China

This was intended to reduce flooding and deposition of sediment in the lower reaches of the Yellow River by a number of measures undertaken in the upstream area: construction of structures to trap sediment; modification of land form; modification of land use.

The flood prevention benefits were valued indirectly in terms of avoided expenditures - preventive expenditure on raising dikes, restoration costs of desilting irrigation systems, and the opportunity cost of water used for flushing sediment.

- *Contingent valuation method* The contingent valuation method (CVM)

relies on direct questioning of people to determine their willingness-to-pay valuation of an environmental impact. A detailed description of the environmental impact is provided, and interviewees are then asked what they would be willing to pay (WTP) for a hypothetical environmental improvement, or to accept (WTA) as compensation for an environmental deterioration.

The contingent valuation approach may, in principle at least, capture the totaleconomic value (use and non-use components), whereas other techniques may only provide estimates of direct or indirect use value.

Box 5: Example of Continguent Valuation Method: National Park Project, Madagascar

CVM was used to value the loss of benefit to local communities of refraining from using the Mantadia National Park. Local residents were asked whether they would be willing to accept specified levels of compensation to forego access to the forest. These estimates were then used as a measure of the costs imposed on the local community by the loss of access to the Park. CVM was also used to estimate the benefits to international tourists from visiting the Park.

- *Surrogate market valuation method* Whilst an environmental good or service may not be traded directly, it is sometimes possible to find a good or service, related to the non-marketed environmental item, that is sold in markets. In this situation, the individual may reveal his or her preference for both the market and non-market good or service when making a purchase. It may then be possible to separate-out the environmental component of value from the observed market price, and in this way use this component of market price as a 'surrogate' for the environmental value.

There are two main techniques which have been used for applying the surrogate market method: travel cost method and property value (hedonic price) method. Each method is described, together with examples of their application in developing countries.

- Travel cost method

Many natural resources (eg. a national park or lake) are used for recreational purposes. The travel cost method bases its valuation on the money and time costs of visitors to such recreational facilities.

Box 6: Example of Travel Cost Method: Elephant Viewing Safaris in Kenya

The travel cost method was used to estimate the value of safaris and the contribution that elephants make to this value. The cost of travel was estimated using data on land travel costs, air fares and travel time. To identify the contribution that elephants make to the value of a safari, tourists were asked to allocate the enjoyment of their trip over various categories of experience, including viewing elephants. The proportion attributed to elephant viewing was applied to the total travel cost valuation to give a viewing value for elephants.

Property Value (or Hedonic Price) Method.

The hedonic price method is based on the idea that differences in property prices can be used to infer the value which individuals attach to the difference in environmental quality between properties. For example, the difference in the price of two properties which differ only in, say, the local air quality, will provide a measure of the value which people give to difference in air quality. Even when properties differ in other ways, it may still be possible (though it is a complex task) to uncover the implicit prices of environmental quality using statistical techniques to separate out the contribution of each factor to the total market price.

Box 7: Example of Property Price Method: Slum Improvement Project,

Visakhapatnam, India

In 1988 the UK Overseas Development Administration started a major programme to improve 170 designed slum areas. The programme included physical infrastructure improvements, improved water supply, public toilets, community centres and primary health care services. The average change in property prices over a three year period was calculated for slum areas that were included in the improvement programme, and for areas that were not included. The difference in values was taken as a measure of the benefits accruing from the slum improvement scheme.

3. Benefit transfer

Benefit transfer involves deriving estimates of economic value in one context for use in a different context, where the data required for the estimation are not readily available. For example, the value of health damage from air pollution in one city might be used to estimate health costs from air pollution in a different city or, more controversially, the values derived in one country might be transferred for use in a different country. Though this can provide quick and low-cost estimates, it is subject to a number of limitations (see Table 6.1)

Table 1 summarises the main valuation techniques and lists some of the advantages and disadvantages of each method.

Table 1: Valuation Methods

Valuation Method	Advantages	Disadvantages
Change in output of marketable resources and goods	easily understood and applicable, provided dose-response relation is known uses actual market prices	difficult to isolate the effect of given impact on observed change in production market prices may be a poor indicator of willingness to pay only relates to use value
Human capital cost	applicable where: epidemiological dose-response data health expenditure data, and earnings data are available	likely to understate full value of health difficult to isolate separate causal factors in ill health moral and ethical objections
Cost based approaches (Replacement cost or preventive expenditure)	ease of application, if relevant technical and cost data are available	preventive expenditure may understate environmental value replacement cost may understate full reinstatement of environment quality may not cover non-use values
Contingent valuation	potentially covers most components of total economic value practice improving with greater experience in its use	time-intensive and expensive to implement biases through use of stated rather than revealed preferences other biases associated with questionnaire design and survey practices
Travel cost	a fairly well developed and used method	significant data requirements problems in reliably interpreting the statistical findings measures use value only
Property valuation/hedonic pricing	applicable where there is: availability of property price data availability of data relating to determinants of property prices	assumes market values capture the environmental good's value problems in segregating the influence on property prices of environmental factors from that of other explanatory variables measures use value only

Benefits transfer	time saved and inexpensive applicable where value estimates are available from other comparable studies	inappropriate transfer of values from sites where primary analyses were conducted to sites experiencing different, non-comparable conditions

INTERTEMPORAL CONSIDERATIONS: CHOICE OF DISCOUNT RATE

Economic values that arise in the future may have a lower value than the equivalent value arising in the present. Discounting is the process whereby future values are converted into their equivalent present-period values, using discount rates, which then allows the stream of future values (benefits and costs) to be aggregated into a single net present value sum (NPV) estimate.

In the discussion on financial project appraisal we saw how the net cash flow was discounted to give the project's net present value. To do this required a choice as to the rate of discount and in the financial analysis the market rate of interest was used on the grounds that it reflected individuals' rate of time preference.

The same discounting procedure is applied to the stream of shadow net benefits over the life of the project, using a shadow rate of discount which is usually referred to as the social discount rate. The argument for using a shadow rate of discount, rather than the market rate of interest, is the same as for the project's benefits and costs, namely that there are market imperfections or distortions which cause the market interest rate to deviate from its efficiency (shadow) value. For example, the government may operate a policy of controls on interest rate levels, or may allocate investment funds at subsidized rates to certain users. If the market rate of interest is judged to be 'distorted' it is necessary to calculate the opportunity cost of the funds that are to be invested in the project. Since the capital invested in the project could be invested elsewhere in the economy, it is argued that the opportunity cost should be measured by the marginal rate of return on public sector investment.

Unfortunately, the application of this approach to calculating the social discount rate is not easy in practice, and the estimated shadow rate of discount will frequently be a rough approximation. It will therefore often be necessary to treat the social discount rate as the bestguess as to its 'true' value and to calculate several NPVs for the project, using a range of discount rate values to test for the sensitivity of the project's NPV to the choice of discount rate.