1. Editors' introduction

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UNDERLYING THEORY

Project cost–benefit analysis (CBA) in the context of developing countries has its practical roots in the work on water resource planning in the US in the 1930s and its theoretical foundation in the new welfare economics of the 1940s (Little, 1950).¹ The key feature is the insight that in any economy ‘social value’ in the sense of the contribution of any item to social welfare need not be represented by an observable market price – either because real world features of markets depart from competitive optima or because a market does not exist for the item concerned. In this framework holding everything else constant, the social value (P) for item i becomes:

$$P_i = dW/dQ_i \quad (1.1)$$

where W is a measure of welfare, Q is output quantity and d denotes a small change.

Social values in this sense have been variously termed shadow prices, economic prices or accounting prices to reflect their unobservable nature. In this chapter we use the term ‘shadow prices’ although other chapters in the book sometimes use the other terms.

Social welfare itself needs defining. From its origins in welfare economics most project economic analysis takes as its starting point the individualistic social welfare function where total social welfare is the aggregation of individual preferences. Thus where consumers have access to more goods, their willingness to pay to obtain them defines social value.² Two exceptions to this rule have been incorporated into the literature although they are rarely applied in practice. These relate to a specification of social welfare based on judgements by planners or political decision makers regarding the desirability or undesirability of the consumption of particular goods (‘merit wants’) or on the desirability or undesirability of particular patterns of distribution of consumption or income (‘distribution

weights'). Since social welfare is defined in individualistic terms and it is conventional to assume that individual welfare is determined by levels of consumption, it is natural to measure social welfare in consumption units. Thus, assuming there are no items affecting welfare that cannot be measured in monetary terms, the broadest expression for the change in welfare dW is:

$$dW = dC + \sum m.dC(p_m - 1) + \sum r.dC(p_r - 1) \quad (1.2)$$

where C is consumption, m is the share of this which goes on merit goods and r is the share that goes to those above or below mean consumption, p_m is the weight placed on merit goods, p_r is the redistribution weight placed on those with non-mean consumption and $\sum$ refers to summation over all merit goods and individuals.

Savings can be treated as postponed consumption which will accrue in the future. Where there is a savings shortage, by definition, a unit of income saved in the present will be worth more than one unit of consumption in present value terms and the present value of total consumption C will be composed of two components:

$$C = C_1 + S.P^F \quad (1.3)$$

where C_1 is current consumption, S is current savings and P^F is the value of a unit of current savings in terms of future consumption. Therefore equation (1.2) can be rewritten as:

$$dW = (dC_1) + (dS.P^F) + \sum (m.dC_1 + m.dS.P^F)(p_m - 1) + \sum (r.dC_1 + r.dS.P^F)(p_r - 1) \quad (1.4)$$

This basic approach defines the way in which various objectives in addition to increasing consumption – such as favouring merit goods, redistributing benefits and raising savings – might in theory be incorporated in project level calculations. In practice, as we discuss below, these latter adjustments have rarely been made and the focus has been on estimating simply dC or the monetary equivalent where non-marketed benefits are involved.

Conversion of the effects of a project into the monetary equivalent of consumption draws on the basic principles of welfare economics. A project is viewed as a disturbance to a market, creating effects in terms of both demand and supply. In a simple competitive framework there are three possibilities depending upon whether the project is large enough to affect price in the market and whether project output is internationally traded or non-traded:

- the project may affect the balance of payments, in which case the world price provides the measure of value;
- the project may displace other supplies, in which case there is no additional consumption and cost saving measures output value;
- the project may add to consumption directly, in which case willingness to pay measures value.

Where traded goods are produced and the country is a price-taker on the world market there will be a given market price and a perfectly elastic horizontal supply line. Assuming no protection or trade costs and that the restrictions of the perfectly competitive model hold, extra project supply will be absorbed at this ruling price, and if domestic demand is insufficient then the residual supply will be exported. Under these limited conditions, ignoring trade margins, the world market price provides a measure of value. The theoretical link with consumption is that foreign currency values should be converted into domestic currency at an exchange rate that reflects consumer willingness to pay for foreign currency.³ On the other hand, projects can impact on the domestic economy through their production or use of non-traded items. Where projects change domestic prices, then in welfare terms they create changes in consumer and producer surpluses whose value in terms of consumption determines the social value of the projects.

Figures 1.1 and 1.2 illustrate these points. A project is represented by an outward shift in the supply line from SS to SS_1 . Where output is exported and we adopt the small country assumption, all project output can be sold at the world price P_0 and gross benefits will be the area ABQ_1Q_0 in Figure 1.1. Where, as in Figure 1.2, a good is sold domestically and does not affect international trade, the shift to SS_1 will bring price down to P_1 from P_2 and this will create both an increase in demand from Q_1 to Q_2 and a fall in other domestic supply from Q_1 to Q_3 . The gross benefit at the demand margin is the area ABQ_2Q_1C , composed of both revenue (BQ_2Q_1C) and consumer surplus (ABC) and at the supply margin it is ACQ_1Q_3D or total cost savings composed of both revenue loss (CQ_1Q_3D) and producer surplus (ACD). Thus where prices change due to a project, social value is determined by the revenue effect, which is captured by the financial analysis of a project, and the change in consumer and producer surplus, which is not. To capture social value requires quantifying these surpluses and adding them on to financial effects. How far project output replaces other supplies or adds to demand will be determined by the size of the respective supply and demand elasticities at the pre-project price–consumption point.

In a perfect market with no trade barriers each definition of value would be equal. In a small open economy the world price will be the domestic

Figure 1.1 Project output exported at constant price

Figure 1.2 Project output sold domestically

price, and in the non-traded case the unit value at both the demand margin and at the supply margin is the average of the with and without project prices (P_2 and P_1). This is the so-called 'rule of half' which still figures in practical work in some sectors. This follows since, if we assume linear relationships, gross benefits at the demand margin are:

$$P_2*(Q_2 - Q_1) + 0.5*(P_1 - P_2)*(Q_2 - Q_1)$$

and rearranging:

$$(Q_2 - Q_1)*(P_2 + 0.5*(P_1 - P_2))$$

which reduces to $(Q_2 - Q_1)*0.5*(P_2 + P_1)$.

Similarly at the supply margin gross benefits are:

$$P_2*(Q_1 - Q_3) + 0.5*(P_1 - P_2)*(Q_1 - Q_3)$$

which reduces to $(Q_1 - Q_3)*0.5*(P_2 + P_1)$.

However, in real world conditions with taxes, subsidies, monopoly or monopsony power, uncertainty and externalities, there is no reason why the value of mean willingness to pay (at the demand margin) should equal mean cost saving (at the supply margin). In real world conditions there will be wedges (or 'distortions'), sometimes large ones, between these three bases for value, which practical analysis has to estimate.

As the starting point of the competitive market model is a gross simplification of reality, the test for project economic analysis is to find ways of approximating the 'true' or shadow price value of project items, where markets do not exist or where, if they do, they are strongly influenced by taxes, subsidies, monopoly or monopsony power, uncertainty and externalities. The framework underlying Figures 1.1 and 1.2, drawn from welfare theory, provides the starting point for the application of project economics concepts. However, as project economics deals with an imperfect world, its shadow prices are 'second best' prices as opposed to the 'first best' prices that prevail under restrictive theoretical conditions.

EVOLUTION OF THE LITERATURE

The early academic literature focused on adjusting for some of the most obvious market distortions, principally taxes and subsidies. However, the adjustments were asymmetrical as between costs and benefits. As transfers, taxes should be deducted from project costs or from benefits where, at the

supply margin, these are defined in terms of cost savings. However, since taxes that are paid are part of willingness to pay, taxes on outputs should be included in benefits. The seminal figure in this literature was Arnold Harberger, who showed in a number of papers how relatively simple adjustments to market prices could generate approximate shadow prices.⁴

The work of Harberger focused on estimating the first term in equation (1.2) in what were termed 'efficiency' adjustments since they focused on the efficiency of resource use without incorporating growth, distribution or merit want objectives. This approach was expanded significantly to allow for a shortage of savings in the work of Feldstein (1964) and Marglin (1967). The insight here was that, where growth is constrained by lack of savings, a unit of income saved in the present can be treated as postponed consumption whose future value, when discounted back to the present, will exceed the original value of savings. This is the parameter P^F in equation (1.3) derived as the discounted stream of the future consumption generated by a unit of income saved in the present. In its simplest form, with a constant marginal productivity of investment, a constant proportion of the extra income generated in future years reinvested and a constant discount rate,

$$P^F = (1 - s)q/(i - sq) \quad (1.5)$$

where q is the return on additional investment, s is the share of extra income saved and i is the rate at which society's valuation of future consumption declines over time or the 'social time preference' discount rate.

One of the important consequences of this approach was that where P^F is used, the appropriate discount rate should be not the opportunity cost of capital (q) – as in most operational work and Harberger (1973), for example – but a social time preference rate (i). As the latter is typically assumed to be in the range 2–8 per cent and the former is conventionally taken as 10–12 per cent for developing countries, this makes a major change in the weighting of future project effects.⁵

The introduction of merit wants displaces the individualistic basis for valuation and thus implies that social value, as determined by politicians or planners, is higher (for publicly desirable goods) or lower (for publicly undesirable goods) than that defined by the willingness to pay of individuals. Once a premium for merit wants or savings is incorporated in the analysis (as in $P^F - 1$ and $p_m - 1$ in equation (1.4)), a unit of account or numeraire is required, since items with a special weight must be compared with a reference item with a weight of unity. Given the focus on individual welfare, a natural unit is units of consumption as in equations (1.2) and (1.4). This is set out clearly in one of the key texts of the literature, UNIDO

(1972). Written by three of the then leading exponents of applied welfare economics, Partha Dasgupta, Stephen Marglin and Amartya Sen, the so-called UNIDO Guidelines combine academic rigour with an accessible non-technical style. They still stand as a classic statement of project economics.

Although it essentially restated the work of Marglin and Feldstein, UNIDO (1972) added to the literature by showing how distributional issues could be incorporated into project analysis, both through tracing the income flows created by a project and in addition by applying weights to the consumption of different groups to get a distribution weighted measure of project worth. Weights were to be either determined in a revealed preference approach, by examining past decisions to ascertain how far decision makers had in the past traded off gains in total income for gains to a particular group, or treated as an unknown in the form of a switching value calculation. The Guidelines held back from introducing value judgements on distributional issues but at the cost of fairly vague advice on how weights could be determined or used.

Whilst the consumption unit (strictly units of consumption to average consumers) introduced by UNIDO (1972) had an intuitive link with welfare economics, the other key strand of the project economics literature from the work of the Oxford economists Ian Little and James Mirrlees (Little and Mirrlees, 1968, 1974) superficially appeared to move in a quite different direction. Little and Mirrlees were concerned initially with devising a system that would identify projects that were financially profitable due to import protection but that were economically inefficient as project costs were high relative to the import price of the commodity. Much of their focus therefore was on traded good projects, where as noted above, under a set of assumptions, world prices provide the measure of social value.⁶ Little and Mirrlees recognised the need for a numeraire or unit of account but adopted the opposite approach to that of UNIDO (1972). Whereas UNIDO opted for units of consumption, which it measured in domestic prices, Little and Mirrlees (1974) introduced as its unit government income measured at world prices. This appeared initially as a major departure from conventional approaches; however, syntheses soon appeared and, for example, equation (1.4) can be modified readily to convert it to an expression in Little–Mirrlees units. Assuming all government income is invested (or is used for equally valuable purposes) and that the average ratio of world to domestic prices – what Little and Mirrlees term the standard conversion factor – is SCF then, in their units, equation (1.4) becomes $(dW/P^F)SCF$.

Here the welfare change in consumption at domestic prices is first converted to an equivalent in units of government income by division by P^F and the resulting value in units of government income at domestic

Table 1.1 Choice of numeraire

	Little–Mirrlees	UNIDO
Units	Government income (equivalent to saving)	Average consumption
Price level	World	Domestic
Adjustments	Domestic to world prices (by multiplication by SCF)	World to domestic prices (by multiplication by SER/OER^*)
Adjustments	Consumption to savings (by division by P^F)	Savings to consumption (by multiplication by P^F)

Note: * OER is the official exchange rate.

prices is converted to world prices by multiplication by SCF . Once comparable adjustments and assumptions are made in both systems, they give the same accept/reject decision on a project although the resulting indicators of project worth will differ. Critical here is that the discount rate differs between the two systems with the social time preference rate used in UNIDO (1972) and an opportunity cost of capital rate reflecting the decline in the value of government income in Little–Mirrlees (1974). The latter follows since government income is normally treated as being equivalent to investment. In fact Ian Little stated on one occasion that their choice of numeraire was driven by the need to come up with a specification of the discount rate which would be compatible with practice in operational appraisals at the World Bank and elsewhere. Table 1.1 summarises the adjustments in the Little–Mirrlees and UNIDO approaches.

Early discussion of the Little–Mirrlees approach misinterpreted its applicability, thinking it could not be applied in the analysis of non-traded activities where, as we have seen, willingness to pay is the appropriate measure of value at the demand margin where project output adds to consumption in the economy. The approach was cumbersome in that willingness to pay estimates would still be needed, but an extra step of converting these from domestic to world prices was required.⁷

A notable synthesis of the UNIDO and Little–Mirrlees approaches (although it adopted the numeraire of the latter) was given by Squire and van der Tak (1975), who showed how distribution weighting would in principle affect all shadow prices. Unlike UNIDO (1972), which gave no advice on how weights should be derived, Squire and van der Tak (1975) showed how a value judgement on a single parameter, the rate at which the social value of consumption declines – the elasticity of the marginal social utility of consumption – can be used to derive consumption weights

for different groups of consumers. The subjective nature of the judgement is hidden in an apparently technical formula where the weight on a unit of extra consumption to individual i is through a comparison of i 's consumption with the national average and the application of the elasticity parameter. Thus:

$$p_{r_i} = (c_{av}/c_i)^n \quad (1.6)$$

where p_{r_i} is the redistribution weight in equations (1.2) and (1.4), c_{av} and c_i are mean consumption and consumption of i respectively, and n is the elasticity of the marginal social utility of consumption.

PRACTICAL APPLICATIONS

Key users of the methodology were multilateral development banks who needed a means of checking that the projects they were proposing to fund were a sensible use of aid resources. Analysis of financial profitability alone was deemed inadequate in many cases due to a combination of factors:

- difficult to value sectors – either because goods were not sold on a market – such as free provision of health and education services – or where the sale was at prices that did not reflect willingness to pay;
- serious economy-wide controls and tax-subsidy interventions which rendered the market price of key variables – like the exchange rate, interest rates and a range of commodity prices – inappropriate guides to social value;
- inequality in income distribution and a concern that project aid should benefit the poor.

Squire and van der Tak were staff members at the World Bank, and various papers were drafted showing how the weighting approach they devised could be applied (for example Linn, 1977). However, in practice none of the major banks or agencies adopted the full range of adjustments. In terms of equation (1.2), the analysis incorporated only the first term on the right-hand side (or the 'efficiency effect').⁸ In a retrospective piece looking back at project analyses in the World Bank, Squire and Deverajan et al. (1996) identified several reasons for this:

- inability to convince practical people;
- complexity of the data requirements;

- disagreement on how the subjective elasticity parameter driving the weights might be identified;
- a concern that distributional and savings issues would be better dealt with by fiscal or other direct policies rather than by project selection.

The rationale for this omission is that, if allocative efficiency effects can be picked up accurately, other policy instruments can be used to address other objectives. Well prepared project analysis of World Bank projects appears to be associated with the subsequent success of projects once they become operational (Jenkins, 1997; Deininger et al., 1998), so good economic analysis should increase the overall level of resources available for allocation and the distribution of those resources in turn can be influenced by appropriate policy measures.

The choice not to use a savings premium and distribution weights (P^F and p_r in equation (1.4)) was followed by other development agencies and multilateral development banks. In practice, therefore, the unit or numeraire applied in practical appraisal related only to a choice between measuring consumption effects at domestic or world prices, the alternative parameters needed to move between different price levels being the shadow exchange rate factor (in a domestic price analysis) or its inverse, the standard conversion factor (in a world price analysis). Manuals produced by international agencies usually did not specify a preference for one numeraire over the other, but noted their equivalence as the economic internal rate of return would be the same in both analyses provided identical assumptions were used.⁹ Practice is still varied and there is a tendency for the price level chosen to be related to type of project – with analysts preferring to use a world price system in traded good projects (as in agriculture, for example) and a domestic price system for non-traded projects (as in water or transport). If distribution analysis is to be carried out, even with no application of consumption weights, there is clear advantage in conducting the initial appraisal at domestic prices.¹⁰ This follows since distribution analysis traces the income changes for different groups created by a project, and this is operationalised by first estimating the changes created by the financial transactions of a project and then at a second step estimating the changes created by the difference between market and shadow prices. The first set of income flows must be at domestic prices, hence for comparability we need the second set of flows also to be at domestic prices. Hence having shadow prices at domestic rather than world prices is clearly an advantage.¹¹

In recent years the bulk of aid-funded projects subject to economic analysis have been in non-traded sectors and the respective manuals have given considerable attention to the distinction between the demand

and supply margins highlighted in Figure 1.1 as these form the basis for valuation (see ADB, 1997; Belli et al., 2001; Jenkins and Harberger, 1994). ADB (1997) for example stresses the distinction between 'incremental output', which adds to consumption, and 'non-incremental output', which displaces other supply, with willingness to pay determining the value of incremental output, and cost saving the value of non-incremental output. Jenkins and Harberger (1994) add the further refinement of using elasticity weights to determine the proportion of project output that falls into the two categories. This is clearly the rigorous way to estimate project impact, although the accuracy of elasticity estimates available at the time of project appraisal may be open to question.

USE AND LIMITATIONS OF DISCOUNTED CASH FLOW ANALYSIS

CBA is a version of the broad approach of discounted cash flow, which compares future benefits and costs in a discounting framework. When CBA was first adopted in the US in the 1930s the main criterion used was the benefit–cost ratio (BCR). The origin of this indicator can be traced back to the work of Dupuit in the mid nineteenth century and arguably even further to early nineteenth-century US water projects (Hanley and Spash, 1993: 4). Two main variants of this indicator can be used. The first involves a comparison between total benefits and total costs:

$$BCR_1 = \frac{\sum_{t=1}^n \frac{B_t}{(1+r)^t}}{\sum_{t=1}^n \frac{C_t}{(1+r)^t}} \quad (1.7)$$

where B_t is the gross benefit in year t and C_t is the sum of capital and operating costs and r is the discount rate.

The second version involves a comparison of the present value of gross benefits net of operating costs with the present value of capital costs:

$$BCR_2 = \frac{\sum_{t=1}^n \frac{(NB_t)}{(1+r)^t}}{\sum_{t=1}^n \frac{K_t}{(1+r)^t}} \quad (1.8)$$

where NB_t is the gross benefit net of operating costs in year t and K_t is the capital cost.

Subsequent debates suggested that this indicator in either form is unreliable for any form of ranking of alternatives since it does not measure the absolute size of the net benefits. Furthermore, definitional problems as to what items were included in the denominator and the numerator meant

that it could also not be regarded as a reliable indicator of efficiency in the use of resources. The consensus is that the net present value (NPV) is the most reliable indicator for mutually exclusive projects as long as the discount rate is known (see, for example, Layard, 1972: 51). The NPV can be defined by:

$$NPV = \sum_{t=1}^n \frac{(B_t - C_t)}{(1 + r)^t} \quad (1.9)$$

However, if the discount rate is not known and a capital rationing situation arises, the appropriate criterion should be to maximise the return to the scarce factor, in this case capital. In such a case the internal rate of return (IRR) provides a better criterion since it measures the return to capital. However, it suffers from the possibility that it may yield multiple roots and therefore could be indeterminate. Such cases are rather unusual but can occur where a project has a large negative value at the end of its life, examples being decommissioning of a nuclear power plant or restoration of an area degraded by a mine after the mine is exhausted. The IRR can be defined as:

$$IRR = r \text{ where } \sum_{t=1}^n \frac{B_t}{(1 + r)^t} - \sum_{t=1}^n \frac{C_t}{(1 + r)^t} = 0 \quad (1.10)$$

In arguing for the superiority of the NPV as a decision-making indicator, Hirshleifer (1958) pointed out that a pure capital rationing situation was rather unlikely in reality and therefore the argument for using the IRR rested on a rather extreme case.

A possible compromise that is sometimes recommended for capital rationing is to use the ratio of the NPV to the present value of capital costs (K): the NPV/K ratio. This is also a measure of efficiency in the use of capital but does not suffer from some of the problems associated with the IRR. However, it does require the specification of a discount rate. The NPV/K ratio can be defined as:

$$NPV/K = \sum_{t=1}^n \frac{B_t - C_t}{(1 + r)^t} \bigg/ \sum_{t=1}^n \frac{K_t}{(1 + r)^t} \quad (1.11)$$

In all of the conventional indicators of project worth the use of discounting means that the focus is on the returns to an initial investment, the assumption being that projects have an initial net outlay followed by a subsequent net benefit. However, the NPV is less vulnerable than other indicators to the possibility that the critical issue is not the initial

investment but whether subsequent benefits will be greater than costs. This may be the case, for example, in some input-intensive agricultural activities where investment may be small relative to operating costs.

Conventional CBA calculations are normally based on values estimated in constant prices. The argument for doing this rests on the view that the results should not be distorted by whatever the rate of inflation happens to be. If CBA is done at constant prices it is also important that any comparison with lending rates should be with real rates, not nominal rates.

Use of constant prices makes sense in the economic analysis of projects but it is not always very helpful in financial analysis when the most important question is often whether the funds allocated to the project will cover the actual money outlays. In principle, financial analysis should therefore be undertaken at expected future prices allowing for general inflation as well as any changes in relative prices. For commercial projects this has the added advantage that the IRR of the project can be compared with the nominal rate of interest on any borrowed funds. However, to be able to compare a financial analysis conducted at current prices with an economic analysis conducted at constant prices, the financial analysis must be deflated by an appropriate inflation factor. This is particularly important if the results of the financial analysis are to inform an analysis of the distribution of benefits. There are a number of complications in ensuring full consistency, but they can be overcome (Potts, 1996c).

Values of costs and benefit items in expected future prices can be estimated by multiplying by an inflation factor (IF) relating to the expected rate of inflation i in each year up to the year in question. Thus:

$$IF_n = (1 + i_1)(1 + i_2)(1 + i_3) \dots (1 + i_n) \quad (1.12)$$

In principle, constant price values can be adjusted for any expected changes in relative prices but in practice such adjustments are rare, other than correcting for abnormally high or low prices at the time of planning the project. Adjustment factors (AFs) for changes in relative prices for a cost or benefit item d in year n can be made by dividing the inflation factor for d by the general inflation factor IF_n .

Thus with:

$$IF_d = (1 + i_{d1})(1 + i_{d2})(1 + i_{d3}) \dots (1 + i_{dn}) \quad (1.13)$$

$$AF_d = IF_d / IF_n$$

Best practice for cost-benefit analysis would therefore suggest that the financial analysis of projects should be conducted at expected future

(that is, inflated) prices, while economic analysis should be conducted at constant prices with due account of relative price changes where the size and direction of these are expected with some degree of certainty. Decision making should be made on the basis of the NPV where the discount rate is known; however, there are a number of controversies in determining the discount rate. These issues are discussed by Kula in Chapter 7.

As noted earlier, a particularly important issue is the choice between a discount rate based on the opportunity cost of capital and one based on social time preference. In a situation of perfectly competitive capital markets the two would be the same but, as already indicated, conventional assumptions about these two indicators were that the former would be significantly higher than the latter, particularly in developing countries. Whether this is actually true or not is debatable, but it is clear that the choice of discount rate can have important implications for the choice of projects. The discount rate is not neutral in its impact on different kinds of projects or in the extent to which it gives due regard to the interests of future generations and the environment. A number of authors have argued that the 10–12 per cent rates typically used by development banks are potentially harmful.¹² In particular the evidence base for such high estimates of the opportunity cost of capital has not been demonstrated. Meanwhile there has been a major shift towards the use of social time preference rates in EU countries (Evans, 2007). The main rationale for using a higher rate in poor countries is that, where capital is scarce, returns to capital and therefore its opportunity cost will be higher. However, given the increased mobility of capital between countries that has occurred in recent years in response to capital account liberalisation this case may not be as compelling as in previous decades.

It is therefore clear that while there is a good deal of consensus about the situations in which to use particular indicators for discounted cash flow analysis, there is still significant disagreement about the value of the discount rate to be used in their calculation. Similar issues arise in relation to the estimation and use of shadow prices.

NATIONAL PARAMETER ESTIMATION

Two underlying assumptions of Little and Mirrlees (1968 and 1974) were that market prices in developing countries were sufficiently different from economic values to justify the use of shadow prices and that it would be possible for developing country governments to establish what they described as a 'Central Office of Project Evaluation' (COPE) that would have responsibility for their estimation. It was clearly recognised that it

was neither realistic nor sensible to expect individual project analysts to estimate shadow prices beyond those that were very specific to the project in question. In particular the use of different conversion factors (where these are defined as the ratio of a shadow to a market price) for the same items in the appraisal of different projects would render the comparison of projects meaningless and therefore make systematic project selection virtually impossible. It was therefore considered necessary for the COPE to make periodic estimates of what came to be called 'national parameters' or economic values for key factors and sectors. In principle these parameters would then be used consistently for all projects until such time as they were revised.

While there have been many studies undertaken to determine shadow prices in different countries, it is unusual in practice to find a functioning system to ensure that they are updated on a regular basis.¹³ Given that the estimation of shadow prices in the first place often depends on data that are one or two years old, it is clear that such estimates can easily become outdated and therefore of potentially limited value in project appraisal.

The main practical approach to estimating national shadow prices from the 1980s onwards has been through the use of semi-input-output analysis. A review of this method and some of the studies conducted using it is provided by Potts in Chapter 4. The number of studies undertaken suggests that the method itself is fairly robust, albeit subject to the limitations of the underlying assumptions and the data used. The key issues are therefore the extent to which such parameters are used in a systematic way, the stability of the parameters over time and the frequency with which they are updated. Unfortunately practice has been patchy at best in relation to the first and third issues and the second issue is relatively unknown because of the irregular updating of estimates.

A further issue that has influenced practice since the early 1990s has been the impact of economic liberalisation. Almost all countries have liberalised markets to a significant extent in the last twenty years. Arguably this might suggest that the need to use shadow prices might be lessened due to the reduced level of market imperfections. One of the main arguments used for applying shadow prices in developing countries was the level of market imperfection, which was contrasted with the situation in developed countries (Little and Mirrlees, 1974: 29–37). Do we need shadow prices if markets are liberalised? The consensus is that we do.¹⁴ Most countries continue to impose some taxes on trade; unemployment and underemployment are still issues; and monopoly and discriminatory pricing still affect non-traded sectors. The implication is that at the very least there is a need to use a shadow exchange rate and shadow wage rates for different categories of labour as well as to remove taxes and subsidies when

conducting economic analysis. A comprehensive discussion of the estimation of the shadow exchange rate is provided by Londero in Chapter 2 and an overview of issues relating to shadow wage rates is provided by Potts in Chapter 3.

Arguably a more important question is why shadow prices are not used more often in developed countries. The most recent EC Guide to Cost–Benefit Analysis for the regions (European Commission, 2008) proposes an approach that is very similar to that proposed by Squire and van der Tak (1975) in a developing country context. In Chapter 12 Florio and Vignetti describe the CBA method proposed for use in the EU regions as ‘bridging the traditions’. A number of authors have either estimated shadow wage rates for developed countries or argued for their use and it is quite likely that the methodological distinction between CBA for developing countries and CBA in the developed world will become increasingly blurred.¹⁵

DIFFICULT TO VALUE NON-TRADED SECTORS

In recent years multilateral development banks have concentrated their project support on sectors providing either physical or social infrastructure, which are of their nature difficult to value. As noted above, in theory, willingness to pay provides the basis for valuation of incremental non-traded output. Strictly what is required is the compensating variation in income terms that exactly offsets the price change created by a project, which differs from the conventional area under a demand curve. However, in practice, estimation is based typically on approximations of the latter. Here we highlight three approaches of varying degrees of sophistication which have been applied in some non-traded sectors, particularly in water, where serious efforts have been made in recent years to quantify willingness to pay.¹⁶

The simplest approach is to apply a version of the rule of half discussed above. Where a water project provides piped water to a previously unserved area, and serves households who had previously obtained water from vendors, the average vendor charge per m³ provides the without-project price (P_1 in Figure 1.3). The proposed water tariff to be charged by the project is the with-project price (P_2 in Figure 1.3). With the project water consumption has risen from Q_1 to Q_2 . Assuming a linear demand function, total willingness to pay can be approximated by $0.5*(P_1 + P_2)*(Q_2 - Q_1)$. The approach is crude and implies that vendor and piped water are identical commodities so that a single demand line is applicable.

Figure 1.3 Simple rule of half

A slightly more rigorous approach extends the analysis to relax the linearity assumption.¹⁷ The non-linear demand function can be defined as a semi-log function:

$$\ln q = \alpha + \beta p \quad (1.14)$$

where $\ln$ is the natural logarithm and $\alpha > 0$, $\beta < 0$, q is quantity, p is price. The price elasticity (η_p) is given by:

$$\eta_p = (dq/dp) (p/q) = \beta p \quad (1.15)$$

where d is the change in either quantity or price.

This functional form also has the desirable property that marginal willingness to pay rises exponentially as quantity supplied falls, as suggested by economic theory. The parameter α depends on income, the prices of substitutes, and other non-price variables that determine the demand. This functional form lends itself readily to calculating willingness to pay or economic benefit (EB), defined as the area beneath the demand curve between the existing and new outputs (q_1 and q_2), that is,

$$EB = \int_{q_1}^{q_2} p dq \quad (1.16)$$

where q_1 to q_2 is the range of integration. Integrating with respect to q results in a willingness to pay of:

$$EB = q_2(p_2 - 1/\beta) - q_1(p_1 - 1/\beta) \quad (1.17)$$

where p_1 and p_2 are prices corresponding to q_1 and q_2 , respectively.

Use of equation (1.17) to estimate benefits requires information on β , the slope of the demand function. This requires estimation in an econometric demand model.

A further level of rigour is introduced by contingent valuation approaches that attempt to assess willingness to pay from specially designed surveys (Whitehead and Blomquist, 2006). In a closed-ended approach the respondent is asked whether they are willing to pay a specified amount presented as the value of the improved service. Prices for the service, or 'bids', are set within a range and distributed randomly to respondents. The yes/no answers to the question of willingness to use the service become the dependent variable in a probit regression model where they are related to household, area and service characteristics as well as the bid price. The probit model will be of the form:

$$Y = \alpha + \beta_1 X + \beta_2 B + \varepsilon \quad (1.18)$$

where Y is the yes/no response, X is a vector of variables reflecting household, area or other characteristics, B is the bid price and ε is an error term.

Mean willingness to pay (WTP) is derived from the expression $(\sum(\beta_1 * X^a)/\beta_2)^* - 1$ where X^a is the mean value of X variables.

Mean WTP is thus derived by first summing the product of the mean value for the explanatory variables and their coefficient from the probit analysis $\sum(\beta_1 * X^a)$ and then dividing this by the coefficient on the bid price (β_2). This expression is then multiplied by minus unity to give a positive number. Where there is a constant in the probit model (α) this must be added to the sum of the products to give $\alpha + \sum(\beta_1 * X^a)$ so that mean WTP becomes $(\alpha + \sum(\beta_1 * X^a)/\beta_2)^* - 1$.

The same approach can be applied to derive mean WTP for specific target groups by replacing the average value for each variable X with the specific X value for the group concerned (for example for the very poor).

Measurement of benefits in the water sector can be regarded as potentially problematic but there are well established approaches for measuring the benefits of roads. These have been embodied in computer packages such as HDM-4. Various versions of this model link road quality with the cost of operating a vehicle to allow a specified road improvement to be converted into a saving in vehicle operating cost. In Chapter 9 Nash discusses the methods of measuring the benefits of road projects. At the simplest level vehicle operating cost savings provided the benefit for existing

traffic with the rule of half applied using vehicle operating costs as proxies for consumer prices to value incremental traffic. Such benefits are more difficult to establish for rural roads where there may be little information on traffic or where roads previously did not exist. However, the role of rural infrastructure in improving the opportunities of the rural poor can be very important.

Similarly well established methods are available for appraising energy projects, especially where one source of energy is replaced by another such that the economic value is derived from cost saving from energy substitution. However, the energy sector faces similar problems of demand estimation to the water sector in the rural areas and similar methods may be used to value incremental demand.

Both the transport and energy sectors can involve particularly heavy investment costs and as a result they are the most likely sectors to be subjected to more sophisticated approaches to risk management. However, all projects are subject to some degree of risk or uncertainty and so methods are required to assess the potential sources and scale of risk and potential strategies to deal with possible negative outcomes. The analysis of risk is discussed by Weiss and Ward in Chapter 6.

VALUING THE ENVIRONMENT

The same contingent valuation survey approach described above in relation to water can be applied to other 'hard to value' activities, including aspects of the environment, although it is recognised that explaining to respondents the concept of paying for environmental amenities is not always easy and, if it is not fully understood, the utility of this approach is seriously undermined. The application of project analysis techniques to environmental issues has been a major growth area in recent years, principally in terms of how to place monetary values on environmental effects. However, there has also been a discussion of how conventional decision criteria on projects (including the discount rate) need to be modified to address issues of environmental sustainability (see Chapter 8). A majority of applications of environmental valuation have been in the context of developed economies; however, an increasing number of rigorous research-based case studies are now available for developing countries.¹⁸

All projects have environmental effects of some sort, and where serious damage is anticipated it is now standard to try to internalise this by incorporating mitigatory expenditure into project design. Problems for valuation arise where

- the project goal is to create an environmental benefit – such as restoring wetlands or removing air pollution;
- mitigatory activity can be only incomplete so there will be a residual negative externality;
- there is a risk of unforeseen environmental damage.

In discussions of environmental value it is conventional to distinguish between use and non-use value, since, unlike other goods, effects on environmental goods can have a value that is in addition to any benefit arising from direct use. The environment is valuable to users because it provides a range of services: the supply of natural resources, the assimilation of waste and the supply of aesthetic benefits, such as beautiful views or rare species. In addition, because of uncertainty regarding the future supplies of non-renewable or non-reproducible environmental resources, users may be prepared to pay a premium simply to guarantee that supplies will be available in future. This 'option value' is a form of insurance premium and, since it is related to future use of the environment, it is a form of use value. Option value is an important element in the argument for the preservation of biodiversity.

Non-use value arises because the environment and its resources may be deemed valuable in their own right independently of any use; thus individuals may value environmental resources or natural species (for example, tropical forests or a rare butterfly) not because they will ever use or even see them, but because they are judged to be of intrinsic value in their own terms. The motives here could be a mixture of genuine altruism and a sense of responsibility to future generations, including individuals' own families. This form of value is normally termed 'existence value', with a concern for one's own family in the future termed a 'bequest value'.

Total environmental value for the environment is composed of the sum of use and non-use values. However, not all potential sources of value can simply be summed to give total value, since some sources of value may be incompatible; for example, some direct uses of tropical forests may preclude the protection of rare wildlife and thus reduce existence value. Hence total environmental value must be based on a compatible set of environmental functions.

Chapter 8 by Anand discusses environmental issues in more detail but there are several approaches to environmental valuation. The most common approach in operational project work is to estimate the economic value of environmental use by the tangible goods and services whose availability is affected by a project's environmental impact. Since such goods and services are marketed in one form or another this approach is said to be 'market-based'. It can be related to both output

loss through environmental impact or the mitigatory cost involved in negating that impact. The former case requires the establishment of a relationship between a project and certain environmental parameters (such as soil or air quality) and then a second relationship between these parameters and production. This is the 'dose-response' methodology, where an environmental change (a dose) is linked with a change in production (a response).

The most obvious examples of this approach relate to projects which alter the pattern of land use and thus change output; where output change results from the environmental effect of a project the economic value of this output gives the basis for use value. A timber project, for example, will reduce the products that can be obtained from the forest in its natural state. Their value may not always be easy to estimate, partly because some of the products may not be sold in a market, so that proxy values based on marketed alternatives must be used. Similarly, from a different perspective, planting of trees as shelter beds will be expected to raise crop yields, and the value of these crops will provide an estimate of environmental benefit from tree planting. The use of world prices to value internationally tradable outputs will be relevant where the goods concerned can be exported or sold to replace imports.¹⁹

A form of environmental use value that has received considerable attention in recent years is the carbon store function of tropical forests, since if forests are cleared, this carbon will be released into the atmosphere, contributing to global warming; the damage attributed to global warming in terms of lost output gives a measure of the effect from this form of use value of forests.²⁰ This benefit is global rather than national, and if the perspective for appraisal is that of a national economy, citizens of the economy in which the forests are located may gain little from this effect.

There will clearly be some environmental use value for which market transactions will not be relevant, since no market exists for the type of effects involved. The approach of 'surrogate markets' involves using data from existing markets as proxies for the relevant environmental values. The key requirement is that the market used must be influenced by environmental effects in a quantifiable way to allow a revealed preference approach to valuation. The two best-known revealed preference approaches to environmental valuation are the 'travel cost' approach and the use of property prices in the so-called 'hedonic price' model.

The idea of the travel cost approach is that individuals and their families incur costs in terms of travel in visiting sites of natural beauty and recreation, such as parks or beaches, and that this cost can be used as a means of eliciting what people are willing to pay for these environmental services,

even when no access charges are imposed. Since these costs are actually incurred when visits are made, this is a revealed preference approach. Travel cost defined broadly to include the cost of time can be used to establish a demand curve for visits to a site of natural beauty where travel cost acts as the price to which demand is related.²¹

The thinking behind the hedonic pricing approach is that in some markets environmental factors will influence price, and if their independent influence can be identified, this should give an approximate estimate of willingness to pay for the environmental factor concerned (and hence a proxy for total economic value, not just use value). The approach is used most frequently in relation to property markets, where it is reasonable to assume that air and noise pollution, access to scenic sites and recreational facilities, as well as the location of environmentally hazardous facilities, impact on house prices. Property prices will be influenced by a range of factors: the characteristics of the property itself (such as age, size, number of rooms, aesthetics); the characteristics of the neighbourhood in which it is located (such as crime rate, availability of public transport, access to schools); and environmental factors (like noise and air pollution levels and access to recreation sites). In principle, a well-specified regression analysis can identify the separate impact of environmental measures on property values controlling for everything else.²² Although a hedonic price approach has been used widely in a developed economy context it is probably only in the higher-income developing economies that property markets will be sufficiently well developed for it to be applied, since where markets are thin there is the risk that prices respond to speculative pressure rather than underlying market conditions. Further, there is the more serious restriction that for many environmental effects implicit markets will not be available. This applies particularly to biological resources relating to rare species and ecosystem diversity. Since markets that relate even indirectly to these natural assets do not exist, implicit markets offer relatively little help in the valuation problem, and a direct stated preference or survey approach will be required.

The valuation approaches discussed so far have the significant limitation that they address only the use value of the environment. If the other components of environmental value – that is, option and existence value – are to be quantified, this can be done only by direct survey techniques that elicit a subjective response to the value placed on the environment. This is the third of the possible approaches and involves contingent valuation studies on environmental effects. All such studies need to avoid sources of bias, but these can be particularly serious where valuation is for intangible environmental benefits. For example, if respondents think their answer

has no impact on pricing but they want to obtain or preserve the resource, they may overstate their willingness to pay (strategic bias), whilst respondents may have difficulty distinguishing one part of an environmental resource from the whole, for example protecting one lake from a series of lakes (part-whole bias). Similarly respondents may be uncomfortable with placing a value on something they have never purchased. Hence the way in which the problem is explained to respondents may influence their answers (information bias). A considerable effort has been exerted in the literature to design surveys that minimise these and other sources of bias, but the potential for error must be borne in mind.²³

Contingent valuation for environmental effects is now a widely accepted procedure in both academic and policy circles. A major step in its acceptance was the work on valuing the impact of the Exxon Valdez oil spill in Alaska in 1989. A special panel of distinguished academics appointed by the US government concluded that contingent valuation studies were sufficiently reliable to be used as evidence in the US judicial process in assessing environmental damage (Arrow et al., 1993). Furthermore there is also evidence of consistency of results over time, with studies showing a reasonably high correlation between willingness to pay estimates for environmental protection at different points in time (Carson et al., 2003). The UK government has also used contingent valuation techniques to aid decision-taking on environmental issues.²⁴

Work on valuation of the environment has been given added impetus in recent years by the growing concern over climate change and the potential economic damage caused by alternative scenarios for temperature rise. The Stern Review (Stern, 2007) quantified the damage from various natural events triggered by climate change – such as drought, floods, sea level rise and typhoons – which will either necessitate mitigatory expenditure (valued at its cost) or create damage like loss of crops (valued at their export price) and broader impacts on health and ecosystems. A comparison between projected costs of adaptation and benefits in damage avoided becomes a very aggregate cost-benefit calculation which shows high returns in the very long term, although these results are sensitive to the discount rate chosen.²⁵

DISTRIBUTION AND POVERTY OBJECTIVES

The focus of literature in the 1970s in relation to poverty objectives was on the use of distribution weights. Experiments were made with adjusting shadow prices, particularly the shadow wage rate for unskilled labour, using weights that reflected the trade-off between growth and distribution,

but as noted above they were not widely adopted in practice. The alternative approach to dealing with distributional issues is to measure the distributive impact of projects. The way to do this was implicit in the 1972 UNIDO Guidelines and demonstrated more clearly in the subsequent Guide (UNIDO, 1978) and a book of case studies (UNIDO, 1980). A more comprehensive theoretical statement of the approach was developed by Londero (1996a). The essence of the approach is to work out not just the value of the economic NPV but also who gets the benefits and who pays the costs. In principle the financial analysis can identify the direct beneficiaries, and any adjustments made to account for externalities or differences between shadow prices and market prices can be attributed to particular stakeholders. For example, tax changes will affect government income and the difference between the shadow price of unskilled labour and the market price can mainly be assumed to be an income gain to workers. With the rapid development of spreadsheet capacity it is no longer a problem to derive an annual statement of the distribution of costs and benefits that matches the annual statement of the economic value of costs and benefits at shadow prices.

With such a distribution analysis the question of what distribution weights to use becomes less of an issue. The important policy issue is who gets the benefits (Potts, 1999). With the advent of the Millennium Development Goals the focus of international agencies on poverty reduction was emphasised. The question then arose as to the specific impact of projects on poverty reduction. The most prominent organisation involved in establishing how to identify the poverty impact of projects has been the Asian Development Bank (Fujimura and Weiss, 2000; ADB, 2001; Weiss, 2004). However, as with shadow pricing, practice falls behind the theory and while we know how to assess poverty impact it is relatively rare that it is actually done in a systematic way. In Chapter 5 Fujimura discusses the issues relating to and lessons learned from the conduct of poverty impact analysis.

It is often argued that an emphasis on social sector projects, particularly health and education, is pro-poor. However, these sectors are rarely subjected to systematic investment analysis and the use of CBA there is relatively rare. The work of Psacharopoulos and associates (Psacharopoulos, 1994; Psacharopoulos and Patrinos, 2002) has been used to argue that returns to education and primary education in particular are both relatively high, and are likely to have a positive impact on distribution. However, the validity of their methods has been criticised, particularly by Bennell (1996b). Educational cost-benefit analysis and the alternative use of cost effectiveness analysis (CEA) are discussed by Potts in Chapter 11.

CBA is even more rarely used in the health sector but in recent years

the use of CEA in relation to health outcomes has become increasingly common. This has relevance to poverty reduction since the poor are disproportionately affected by high rates of morbidity and premature mortality. It can therefore be used to establish the potential impact on poverty reduction objectives (Weiss, 2003). The methods available for use in appraising the effectiveness of health sector projects and programmes are discussed by Weiss in Chapter 10.

The association of pro-poor projects with activities in the social sectors has been accompanied by a relative decline in the attention paid to agriculture. This may seem surprising given the prominence of agricultural and agro-industrial projects in the early literature on CBA in developing countries. A classic text developed originally in 1972 and subsequently extended in a second edition (1982) was Gittinger's *The Economic Analysis of Agricultural Projects*. Given the importance of agriculture as a source of livelihood for the majority of the world's poor it was not surprising that a significant proportion of World Bank funding in the 1970s and early 1980s should have been concentrated on the agricultural sector. The ideological shift in the donor countries in the 1980s that influenced subsequent structural adjustment policies regarded agriculture as a commercial activity that belonged in the private sector. As a result, donor funding of agricultural interventions declined. At the same time, donor funding also shifted towards sector programmes and budget support and away from projects. These two factors led to a relative neglect of both cost-benefit analysis (as a project related tool) and of the agricultural sector. For a long time development policies that proclaimed the importance of poverty reduction paid little attention to the sector from which, even in a rapidly urbanising world, the majority of poor people obtain an income.

While the general features of the technical approach to the economic appraisal of agricultural projects have not changed significantly since Gittinger's books were published, there have been changes in emphasis and in the issues addressed, and a substantial change in the capacity of spreadsheets and related software to deal with the complexities of the sector. The changes in emphasis and issues include greater attention to environmental sustainability, greater gender awareness and recognition of the importance of understanding rural livelihoods.²⁶ Particular features of the livelihoods approach include the attention paid to the different forms of capital employed by rural households and the diverse strategies used to sustain them. A further change in emphasis has been the almost universal withdrawal of the state from directly productive agricultural activities. As a result the economic analysis of agricultural projects is now largely confined to enabling projects oriented to small farmers and commercial projects funded by development banks, often with an outgrower

component. Paradoxically, despite the decline in attention paid to the sector, the expansion of software capacity has made the analysis of diverse production systems and related issues of risk and the distribution of benefits much more feasible.

There are some signs that the tide is turning, both in relation to the use of cost–benefit analysis and in the attention paid to agriculture. The World Development Report for 2008 (World Bank, 2007) was titled *Agriculture for Development*, and this has been accompanied with an increase in funding to support the sector. A recent review of the use of CBA at the World Bank (World Bank, 2010) found that the proportion of World Bank projects for which CBA was undertaken had fallen from 70 per cent in the 1970s to 25 per cent in the early 2000s. About half of this decline was due to the shift in lending towards those sectors for which CBA is not usually undertaken. However, there was also a general decline in the use of CBA despite the observation that performance improvements were most evident in those sectors that do use CBA. It is, however, clear from the importance attached to the document that the World Bank is committed to the continued use of CBA in the sectors for which it is feasible and also to ensuring improvement in the practice of conducting such analysis.

CONCLUSIONS

Project CBA provides a framework that allows costs and benefits to be assessed consistently both for an individual project and across projects. As such, its validity depends upon how accurately costs and benefits can be identified and valued. The test for its usefulness is not comparison with an abstract classroom case study that assumes away information difficulties but with alternative ways of decision making under the uncertainty that prevails in the real world. In their different ways the chapters in this volume make the case that practical application of CBA offers an important aid to decision making that is superior to hunches, simple rules of thumb or multi-criteria approaches that list different project effects without converting these to monetary equivalents.²⁷

Project CBA in the development context was developed initially as an aid to planning the participation of countries in international trade by stripping away the impact of a system of trade controls. Since traded outputs are valued at world prices (not at the world price plus the relevant import tariff) and the domestic resources needed to produce them are valued at their opportunity cost, CBA provides a means of making operational planning along the lines of comparative advantage. Activities with low opportunity costs relative to world prices – for example due to a

labour surplus or abundant natural resources – appear attractive in cost–benefit terms. The removal of the majority of trade barriers in much of the developing world over the last two decades has lowered the divergence between domestic and world prices and made this aspect of CBA less critical, since in such liberalising countries trade protection now has a much weaker impact on financial profitability. However, the continued existence of unemployment and some taxes on trade in both developed and developing countries means that these issues cannot be entirely ignored.

Meanwhile other developments have increased the relevance of CBA. First, the poverty focus of aid initiatives over the last decade has brought the question of the poverty impact of projects to the centre of attention. It is not straightforward to trace who gains and who loses from a project and in practice it is typically only first round effects that can be estimated. However, project CBA provides a clear framework for undertaking this exercise. Knowing how a project is likely to affect the poor has become a critical question for many donors and even approximate estimates are welcome.

Second, developments in survey methodology now allow a much more sophisticated approach to estimate the value consumers place on a range of project outputs, some of which may not be sold in a market. The contingent valuation approach is being applied in a range of sectors and offers a practical solution to the problem of estimating willingness to pay. Again there are qualifications regarding the quality of survey design, the difficulty of transferring results from one location or context to another and the need to avoid various forms of bias. However, the increased application of such surveys has made possible practical valuation in what used to be thought of as intrinsically ‘hard to value’ activities, and in doing so has given a major boost to the use of CBA.

Finally, textbook discussions have always highlighted environmental effects as a classic form of externality overlooked in the financial analysis of a project. The debate on climate change and the environmental impact of new projects has underlined the need to include such externalities in project calculations and the very extensive and rapidly growing literature on environmental economics has provided the means of quantifying and valuing environmental effects. A full assessment of environmental policy requires much more than project-by-project calculations, but a useful starting point is a discussion of how far individual projects create effects, how far these effects are internalised by mitigatory expenditure undertaken by the projects themselves and how far they remain as externalities. The toolkit of project economists has been expanded significantly by drawing on development in the environmental economics literature (see Pearce et al., 2006).

In short, this volume argues that project CBA remains both valid and relevant for development many years after it was first recommended to developing countries. Priorities and challenges may look different today from fifty years ago, but a cost versus benefit comparison is central to any rational form of decision taking, and the CBA literature, with the modifications discussed in this volume, offers a practical and relevant framework to guide decisions on resource allocation.

NOTES

1. The 1936 Flood Control Act in the US mandated agencies working in the sector to justify investments on the grounds that benefits exceeded cost, where it was clear that as water was a largely non-marketed item financial analysis would not reveal the true picture (Marglin, 1967: 16–17).
2. Strictly, in the context of a price reduction, this should be based on compensating variation – the amount of money the consumer can receive and still be as well off as before the price reduction – rather than on the area under the demand curve.
3. The link between world prices and consumption benefits through a shadow exchange rate (SER) is made clear in UNIDO (1972, Chapter 16).
4. Harberger (1973) has a collection of these key papers.
5. The issues relating to estimation of the social time preference rate are discussed by Kula in Chapter 7.
6. The proposition that world (producer) prices provided the basis for social value was analysed in depth in Diamond and Mirrlees (1971) and found to hold under a range of scenarios.
7. Little and Mirrlees (1974) suggested that this could be done though an average conversion factor for consumption, although in principle this aggregate measure could be replaced by specific conversion factors for consumer groups. Ray (1984: 55–7) shows how willingness to pay figures in the Little–Mirrlees system.
8. Merit wants do not figure in Squire and van der Tak (1975), and after being raised in Marglin (1967) and UNIDO (1972) their inclusion was not pursued by others.
9. See for example ADB (1997).
10. This issue is discussed by Fujimura in Chapter 5.
11. Although the financial income flows can be adjusted to world prices this is an extra step which is often not well understood.
12. For a range of views on this issue see Markandya and Pearce (1988), Birdsall and Steer (1993), Cline (1993), Potts (1994), Livingstone and Tribe (1995), Price (1996a and 1996b).
13. For example both the editors of this book have been involved in studies to estimate national parameters for Ethiopia but the length of time between the first study and the second (about ten years) meant that, while some aspects of the methodology of the original study were relevant to the more recent study, the differences between the new estimates and the original values were often substantial.
14. See for example Belli et al. (2001: Chapter 5), Curry and Weiss (2000: 326–30), Potts (2002: 354–5), Campbell and Brown (2003: 13–14).
15. For example Del Bo et al. (2009, 2011) have made estimates for shadow wage rates in a number of European countries and regions. Kirkpatrick and MacArthur (1990) investigated the potential use of shadow wage rates in Northern Ireland and similar work has been done by Honohan (1998) in relation to the Republic of Ireland. Potts (2008) has argued that shadow wage rates could be used for appraisal and evaluation of regeneration projects in the UK. Swales (1997) and Wren (2005) have also argued for the use of shadow wage rates in the UK.

16. Whittington et al. (1991) is one of the path-breaking studies of contingent valuation in the water sector.
17. The discussion here follows Choynowski (2002) who illustrates the approach in relation to power.
18. For example Pearce et al. (2002) brought together 19 case studies mostly using a form of contingent valuation.
19. Dixon et al. (1994) has examples of this change in productivity approach.
20. Brown and Pearce (1994) was an early example of this estimation of the use value of forests based on the carbon store function.
21. For example, Day (2002) uses a travel cost approach to value game parks in South Africa.
22. A classic example of the hedonic approach is a study on house prices in Los Angeles by Brookshire et al. (1982) which estimated the impact of air quality on property values.
23. Pearce et al. (2006, Chapter 8) highlight the key issues.
24. The UK Department of the Environment and Transport commissioned a major survey to establish how much people both close to and distant from quarries would be willing to pay in higher taxes to see a quarry shut and the quarry site restored to its natural condition (HM Treasury, 2003).
25. The Stern Review used the PAGE2002 model developed at the University of Cambridge. A more recent rerun of this model showed the global costs of adaptation expenditure (for example construction of seawalls and development of drought-resistant crops) outweighing benefits until 2050, but with benefits significantly outweighing costs beyond that date (ADB, 2009: 90).
26. See for example Chambers and Conway (1992), Ellis (2000) and Scoones (2009).
27. For a brief discussion of multi-criteria approaches see Potts (2002, Chapter 13). For a more extended discussion see van Pelt (1994).