CHAPTER FOUR

AN OVERVIEW OF COST-BENEFIT ANALYSIS

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4.1 INTRODUCTION

For both governments and individuals, the choice between different ways of investing resources rest to a great extent on an evaluation of the costs and benefits associated with the investments. The alternatives will differ as to the magnitude of the costs that must be incurred, the expected benefits that will be generated, the time scale of both costs and benefits, and the uncertainty of risks surrounding the project. Keeton (1985:3) define cost-benefit analysis as an economic technique used in project appraisal which seeks to encompass in its arithmetic all costs and benefits associated with an envisaged act of investment. It has the potential therefore, to serve as a very useful guide in decision making on the canalization of public investments.

An investment is considered a profitable use of resources for the individual or society as a whole when the expected benefits exceed its cost. Thus, in choosing between alternative investments, individuals or governments try to evaluate both costs and benefits and identify the investments that will achieve the greatest possible benefit in relation to cost.

The technique of cost-benefit analysis has been developed to make this evaluation as systematic, reliable and comprehensive as possible and to eliminate the need for guesswork, hunch or intuition. Cost-benefit analysis is an aid to judgement,

however, not a substitute for it, since future costs and benefits can never be predicted with certainty, and measurement, particularly with respect to the likely benefits of a project, can never be completely precise. Therefore, judgement must be used in the economic appraisal of investment project. The value of cost-benefit analysis is that it provides a framework for evaluating both the magnitude of the costs and benefits, and their distribution over time. Such a framework allows the judgement that must be made in assessing the likely yield of an investment to be explicit rather than implicit and possibly vague.

For example, judgements must be made about the real value of the resources to be used in an investment project since their real value may not be fully reflected in their market price because of distortions in the market, such as exchange controls or government control of wages and salaries. Judgement of this type can be incorporated into the appraisal by means of shadow prices, which are intended to reflect the real value of resources to the economy in the light of social and economic objectives of a country.

Shadow prices reflect the weight given to different objectives, for example, to future growth as opposed to present consumption.

The World Bank uses the techniques of cost-benefit analysis - and, where appropriate, shadow prices and shadow wage rates -

to appraise investment projects. All cost-benefit analysis uses discounted present value of both costs and benefits, and to determine whether the benefits accruing from an investment project will be greater than the costs when both are measured in terms of present values. What is needed for such an appraisal is a convenient summary statistic that expresses the relationship between costs, benefits, and their distribution over time. This information can be expressed in three ways, which yield the following investment criteria: the benefit-cost ratio, which is the ratio of the sum of discounted future benefits and the discounted value of costs; the net present value, which is the value of the discounted benefits of a project minus the discounted value of its costs; and the internal or economic rate of return, which is the rate of interest that equates the discounted present value of expected benefits and the present value of costs (World Bank 1980:38).

The economic appraisal of investment projects by the World Bank and other development agencies is based on calculations of the net present value of projects and also on calculations of the rate of return.

These criteria are never used in isolation to assess the profitability of a project, but they are considered to be one of the essential yardsticks by which alternative investments can be judged (Squire et al 1975:89).

4.2   ORIGINS

Attention to this approach dates back to the nineteenth century according to Prest and Turvey (1966:102). In a comprehensive survey of Cost-benefit Analysis (C.B.A.) they suggest that Dupuit's paper on public utility works in France, published in 1844, was pioneering in this field. However, the widespread application of C.B.A. did not occur until the twentieth century and in its initial stages this was almost entirely in the U.S.A. In the United States it was introduced by the 1902 River and Harbour Act which required the accounting for of costs and benefits to commerce of the various river and harbour projects. Subsequent to this, the 1936 Flood Control Act consolidated the momentum built up in the application of the technique and from here it spread rapidly to other applications and countries.

In the field of education, C.B.A. took rather longer to make an impact and its widespread application appears only to have gained popularity with the tremendous surge of interest in the field of investment in human capital in the late 1950's and early 1960's. A pioneering figure in stimulating interest in this application was Theodore Schultz (1974:119).

Since then there have been a large number of studies on the return to education in many different countries. A landmark in this particular application of C.B.A. is provided in the mid-

1970's by Psacharopolous (1970:149) who attempted to synthesise the results of many such studies.

Parallel with the growth in use of C.B.A. has been growth in criticism of the technique and it is against this background that the more cautious modern approaches to use of C.B.A. are best understood. Initially the focal point of the criticism was theoretical, positive economics was set to being replaced by normative economics. It was realised that embodied in the technique was the need for subjective judgemental assessments. Following this, the centre of criticism switched to the empirical aspects of C.B.A. and a key issue to emerge was the identification problem. In the field of education this problem is particularly severe as one expects earnings differences to be associated with both education and individual ability (amongst other things).

Although there is no unanimity in the position taken up in response to these criticism, it appears that a more cautious approach to the use of C.B.A. dominates. Not all costs and benefits are aggregated, some are left out of the arithmetic and presented as statements of consequence, which are left for the decision maker to weigh up along with the 'partial' C.B.A. results (Blaug 1967:78; Weisbrod 1964:128).

Another standpoint commonly adopted is to abandon the attempt to value the more contentious outputs of public investments and only aggregate the 'hard' data on costs. The idea, then, is to determine various output indices which are compared over time

with aggregated cost data. Almost all authors would
acknowledge that C.B.A. does not yield a 'precise' result but
that it does suggest something useful about the relative
attributes of possible investments (and as such constitutes a
valuable tool to the decision maker).

4.3   **THE MEASUREMENT OF COSTS AND BENEFITS**

The cost of any investment must be measured by its opportunity
cost, rather than simply by monetary expenditures. Economic
(as opposed to financial) analysis of investment in electricity
thus attempts to estimate the total cost of an investment in
terms of alternative opportunities forgone.

All relevant costs and benefits must be included in the C.B.A.
However, in doing this, two problems frequently occur.
Firstly, there is the problem of categorizing the various costs
and benefits. The main problems in this regard arise out of
the variety of terms used to distinguish different effects the
overlapping of meanings of these terms and whether to include
'non-economic' or psychic effects in the analysis. The
argument that everything boils down to economics in the end
will often lead to insuperable evaluation problems.

Secondly, there is the problem of 'double counting' i.e. the erroneous counting of a benefit or cost more than once.

The most common distinction between types of costs and benefits is that made between private and social effects, and the differences between these effects are normally attributed to externalities (alternatively termed spillovers), market imperfections and government intervention. Pigou in his celebrated discussion on the definition of marginal private and social net products provides the basis for a distinction between private and social effects. The private effects are those, "which accrues in the first instance i.e. prior to sale, to the person responsible for investing resources there", while the social effects relate to everything which affects the "national dividend" which describes the material welfare of people. Excluded from consideration are the costs and benefits accruing to people in other countries and any psychic effects (World Bank 1990:68).

The way that government intervention may lead to divergence between private and social effects is roughly through the imposition of taxes, subsidies, exchange control and direct regulation. State intervention cannot be relied upon to equalize the private and social effects because it is often motivated by reasons such as revenue or balance of payments deficits or redistributional considerations, which may work against this equalization.

As a result although private effects completely encompass State intervention in their calculation, social effects usually do not. Besides state intervention, market imperfections and externalities (the latter two being discussed later), differences between the private and social effects can also be attributed to the timing of costs incurred as social costs are incurred as soon as resources are moved but private costs may occur well after this (Psacharopoulos 1970:34).

Both private and social effects may be said to have technological and pecuniary externality components. Technological effects are those which change the satisfaction consumers are able to derive from given resources, e.g. pollution of water and the realization of economies of scale.

Pecuniary effects are brought about through an alteration in the demand conditions facing other markets. However, for practical purposes the distinction between the technological and pecuniary externality effects is not very useful. The example of economies of scale which are realised in other industries illustrate the point. While this is a technological externality, it is brought about through a change in demand and therefore, is also a pecuniary externality. Furthermore, there is a danger that with the inclusion of pecuniary effects in the analysis, that redistribution effects could be mistakenly be counted as externality effects.

By way of example, it is incorrect to count extra café earnings in a certain locality as a result of a newly built highway when the extra trade that these café are getting is merely trade diverted from other cafés on the old road.

4.3.1 THE USE OF SHADOW PRICING

A major valuation problem to which analysts using the cost-benefit apparatus have devoted considerable attention, relates to the inefficiency of market prices as indicators of the social value of particular commodities and the social cost of factor inputs. These inefficiencies arise out of distortions in the economy such as excessively high tariff barriers, politically inflated wages, monopoly profits, administered prices of basic goods and foreign exchange constraint.

It is difficult to estimate shadow wage rates or shadow prices. A certain amount of guesswork is involved since the purpose of shadow prices is to estimate what factors would be paid if their price, or wage, reflected their true economic value. Thus, if distortions in the labour market are so serious that it is estimated that certain groups of workers are paid twice the value of their marginal product, their market wage should be reduced by half to provide a shadow wage rate.

Similarly, if scarcity of foreign exchange means that the official exchange rate in a country underestimates the true value of imported goods and services, then shadow prices should

reflect the shadow exchange rate rather than the official exchange rate, which may be kept artificially low through exchange controls. In this case, the shadow exchange rate is an estimate of the exchange rate that would prevail if the price of foreign exchange were allowed to respond to market forces rather than to administrative control (McMeekin 1971:135; Perraton 1982:74).

The World Bank, for example, uses specially calculated conversion factors, which adjust market prices of imported goods or equipment to take account of foreign exchange shortages, in cases where the use of market prices at official exchange rates would distort investment appraisals (Psacharopoulos 1970:78).

A few attempts have been made to use shadow wage rates and prices to estimate the social rate of return to investment in education in developing countries, but in general, cost-benefit analysis of education has relied on market prices and wages (Dougherty 1972:109). The various adjustments that have been made to earnings, however, to allow for probabilities of unemployment or the influence of ability or other factors, all resemble attempts to establish shadow wage rates, since they are attempts to improve the reliability of earnings as a measure of the true social product of educated labour.

From the point of view of the economy as a whole, the relia-bility of rates of return measures to investment, depends on

the market prices accurately reflecting social costs and benefits.

Distortions imply that market prices do not accurately reflect social costs and benefits and thus adjustments to market prices are desirable for project appraisal. These adjusted prices are variously called shadow prices, social prices or accounting prices. In this section the pricing of commodities is considered first and the costing of the two relevant factor input classes, land and labour, are considered after that (Bennet 1972a:39).

Despite the existence of distortions in the domestic economy it could be argued that market prices should still be used for valuation purposes. There could be other forces at work such as the fear of competition or government intervention which lead monopolistic firms to set prices which would approximate those which would prevail under perfect competition. Furthermore, tariffs, taxes and subsidies could be set as a deliberate attempt by the government to correct for market imperfections. But while these situations may be true for particular cases, they are clearly not generally valid - given the profit motive predominates in the private sector, monopolies will be inclined toward abnormal profit situations, and tariffs and taxes are set for quite different reasons than to correct for market imperfections.

It would appear, therefore, that domestic commodity prices, taken as they are, may not be desirable for C.B.A. purposes (Eicher 1977:180).

One possible solution to domestic distortions is to look outside of the domestic economy for a guideline on prices i.e. at international prices. International prices offer a real opportunity price alternative to domestic prices, but clearly before one may argue that they are directly applicable, the goods should be imported or exported by the domestic economy. This does not mean however, that goods not traded in this way should be left out of the analysis, they could still be valued in terms of the same unit of account (numèraire). Little and Mirrlees are the leading proponents of this approach; "In any price system what matters is relative prices, for these relatives measure the rates at which real goods and services can be exchanged for each other. If one can find, in any otherwise chaotic system, some price relatives which reflect real opportunities open to the economy, then these can be used as sheet anchors. In our system the border (source) prices of traded goods fill this need.

4.3.2 PUBLIC GOODS

Public goods, by definition are characterized both by non-rivalness in consumption and by the fact that the seller cannot exclude non-payers.

Thus, if pure public good is provided to a group, a member can receive the benefits without contributing to its cost. The usual implication is that government intervention is warranted to overcome this free rider problem.

Many goods and services once considered public goods e.g. fire prevention and garbage service meet neither condition of the public goods model. If there is a choice between equal and selective access, the proprietor can exclude and there is no free rider 'problem'. It is increasingly being realized that public goods theory cannot be used to justify the financing and production of the broad range of collectively provided goods (Pasour 1981:453).

Seldom (1985), after analysing government expenditures, estimates that no more than one-third of current government expenditures pose a free-rider problem and recognizes that pricing mechanisms are being developed for some goods traditionally considered to be jointly consumed. Thus, it seems clear that the current method of providing most public services is not rooted in a "free rider" problem. Moreover, as Seldon emphasizes, it is ironic that externalities associated with not charging for goods have received little attention even by many economists.

There is an inherent evaluation problem associated with an equal access system of distribution. When an economic good is provided at no cost to the user, the user has no incentive to

economize but rather has an incentive to use the good or service as though it were a free good. Moreover, there will appear to be a shortage so long as the marginal value of the good or service is positive.

4.3.3 EXTERNALITIES

An externality exists where "a variable controlled by one economic agent enters the utility function of another economic agent" and this influence is unpriced to the controlling economic agent (Hosking 1985:22). There are two types of economic agents between which such an interdependence could exist - producers and consumers. The interdependence described above could be between producers or between consumers themselves or between consumers and producers, but normally analysis focuses on the producers effect on the consumer.

Externalities can be defined in different ways, but for the purpose of linking them with public goods only one division is considered here - excludable and non-excludable externalities. Excludable externalities are of the type which can be priced and thus regulated through the market mechanism.

Non-excludable externalities are not pricable because there is no incentive for consumers or producers to reveal their preferences. No one could prevent the consumer or producer from bénefiting from such a commodity and he would be induced to act as a so-called 'free rider', such commodities are called

public goods (i.e. a non-excludable externality is equivalent to a public good).

Of course, many goods are neither pure public goods in the sense of their absolute non-excludability, nor pure private goods in the sense of their complete excludability in consumption and complete competitiveness in production. Blaug, describes such goods as having varying "degrees of publicness" (Blaug 1982:209).

A common approach to the problem of valuating externalities is to look for market situation where a price is implicitly suggested. One such technique uses property prices as an indicator of externalities, where positive externalities are taken as increasing the value of the property and conversely, negative externalities are taken as decreasing the value of the property. There seem to be considerable differences among economists on the merits of this approach to the valuation of externalities.

On theoretical grounds, it is questionable whether the individual's behaviour in the choice of property is constrained by nothing other than his income and an objective set to the property's attributes and even if this was accepted, it is doubtful whether a complete objective set of quantifiable attributes are practically determined from different individuals in the community.

4.4. CONSTRAINTS WHICH MAY BE INCLUDED IN THE ANALYSIS

After having determined what costs and benefits should be incorporated in the analysis and how they should be valued, the next step in C.B.A. is, as far as possible, to incorporate other factors which may have to the considered in the decision making process. This step takes the form of determining the constraints within which the project functions. The constraints may related to scarcities, such as limited capital, availability of materials and competent personnel; or to welfare considerations, such as the distribution of income; or to risk and uncertainty.

4.4.1 SCARCITIES

Clearly, scarcity constraints are very important at the project planning stage. The scope of the project must take these factors into account. A technique which is commonly used where optimization is sought, given certain constraints, is linear programming. In respect of relevance to C.B.A., perhaps the greatest factor is the scarcity of capital which manifests itself to the public sector in the form of high social opportunity costs of borrowing or budgetary expenditure ceilings. This often makes some form of capital rationing necessary and one way of achieving this is through the determination of cut-off rates of return where a project is only accepted if it is expected to yield a rate of return to the investment higher than the cut-off rate.

4.4.2 WELFARE CONSIDERATIONS-DISTRIBUTION OF INCOME

Over the last half century the Paretian welfare basis for the ranking of different economic situations, for example, before and after a project, have been a centre of controversy. In this section some of the main issues of this controversy are described. As it turns out, whether a cardinal or ordinal approach to the measurement of welfare is adopted, the same conclusions are reached. In both cases it emerges that unless some prior value judgements are made, very little can be said without considerable qualification about alternative economic situations.

Beginning with a cardinal approach it is demonstrated that unless one assumes something of the functional nature of the marginal utility of income function, for example, by some 'arbitrary' specification of a social welfare function, ('arbitrarily determined by the economist in terms of either his normative values or those he determines from a study of the political mechanisms in society); that one has no basis for socially preferring projects. This is followed by a rough description of the paradoxes inherent in the ordinal approach - the only apparent resolution to these paradoxes lying in the conclusion that welfare superiority can only be determined on the basis of distributional criterion - a conclusion no different to that revealed by the cardinal approach.

4.4.3   TREATMENT OF CAPITAL COSTS

Because capital costs have great bearing on decisions of
electrification, special attention must be given to measuring
and defining these costs. In the first place, it is essential
to estimate capital costs accurately and to measure the annual
cost of capital correctly, taking into account armotization and
depreciation. Frequently the cost of projects is
underestimated because of faulty assumptions or treatment of
capital costs.

Capital expenditure is incurred to acquire goods and services
that will be of use over a long period, whereas recurrent
expenditure purchases goods and services of immediate, but
shortlived usefulness. The problem in calculating the total
cost of a project is how to add these two categories of
expenditure and allow for the differences in time scale. In
other words, a stock of capital that is purchased at one point
of time is aggregated (but from which services are consumed
over a period of time) and a flow of services that are consumed
as they are produced.

This calculation is particularly important when the costs of
introducing new media such as radio or television are being
estimated, since a high proportion of the total costs is for
the purchase of equipment that is expected to last for many
years. If this equipment is assumed to have a useful life of

ten years, then the initial capital cost can be divided by 10 to provide a measure of the annual depreciation of the asset. To assume that the annual cost of a project simply consists of annual current expenditure plus depreciation of capital, however, would be to seriously underestimate the social opportunity cost of a project. The purchase of a large piece of equipment or a building locks up resources for a number of years, with the result that alternative opportunities to invest these resources are foregone.

The loss of alternative returns, or interest, must be counted as an additional cost, and the capital must be amortized over its expected lifetime in such a way as to take account of the loss of interest as well as depreciation (Farrel 1982:109; Sirken 1983:74).

This can be done by annualizing capital costs, using a discount rate that represents the interest forgone (that is, the opportunity cost of capital). This annualization is sometimes called imputed rent since an alternative to purchasing the capital asset is to rent it. In the case of public investment, the opportunity cost is the social discount rate. Because of the problems of identifying the social discount rate, some cost calculations use alternative discount rates - say 7,5 per cent and 10 per cent - in annualizing capital costs. Others use shortcuts, for example, the original cost of the capital can simply be multiplied by the discount rate and this annual interest charge added to the annual depreciation. This is only

a rough approximation, however, since it ignores the changing value of the capital asset over its lifetime (Jamison 1977:209).

The correct way to allow for both interest forgone and depreciation is to calculate an annual capital cost, or annualization factor, which is dependent on the social rate of discount, the lifetime of the capital, and the original cost of the capital.

In the terminology discounted cash flow, the annual capital cost is the present value of the annual sum required to repay the original cost of the capital over its assumed life. From the value of the annual capital cost calculated below, it can be seen that the actual value of the annual capital cost depends critically on the assumed rate of interest and lifetime of the capital. If the social discount rate is 15 per cent, for example, extending the lifetime of equipment costing R1 million from five to six years reduces the annual capital cost by R34 000, the same effect would be produced by reducing the discount rate from 15 to 10 per cent, and assuming a life of five years.

In the example below this calculation makes a significant difference of almost 305 percent of the total capital cost. Yet the rate of interest and assumed life of the equipment are seldom discussed in detail in the assessment of the costs of the project, and more attention is paid to items of far less quantitative importance.

Table 4.1:   Total capital costs of a project

Life of equip-ment (Years)	Rate of interest 7,5%	Rate of interest 10%	Rate of interest 12,5%	Rate of interest 15%
5	247	264	281	298
6	213	230	247	264
7	189	205	223	240
8	171	188	204	223
9	157	174	191	210
10	146	163	180	199
11	137	154	172	191
12	129	147	165	184
13	123	141	160	179
14	118	136	155	175
15	113	131	151	171

This is a significant source of error in some calculations of capital costs. Indeed, some cost estimates ignore the problem of interest altogether and use a zero discount rate. The use of an appropriate social discount rate is not just a theoretical nicety, but can make a significant practical difference in the assessment of the real costs of a project (Jamison 1977:312). A zero interest rate implies that the project planner is indifferent to the choice between spending a million rands now or doing so ten years from now. Given the scarcity of funds for capital investment in developing countries, this position is obviously untenable, and to assume otherwise, can lead to a serious underestimate of the costs of an instructional technology project, and an overestimate of its advantages compared with traditional systems, which involve much less capital expenditure (Speagle 1972:228).

4.5 CONCLUSION

In its ideal form project appraisal demands the impossible - it requires that all relevant costs and benefits attributable to a project be specified, weighed against each other on a basis which would enjoy consensus support from society, exactly reflect relevant scarcities, responsible weight the interest on future generations and demonstrate perfect foresight. The aim of C.B.A. is not to achieve this and - some sort of "all inclusive" decision matrix which incorporates all non-quantifiable considerations would be more appropriate for this purpose.

C.B.A. is a technique for appraising the quantifiable aspects of public projects which necessarily involves value judgements and operates with uncertainties.

The pessimist may well argue that this amounts to very little but surely the usefulness of C.B.A. varies from project to project. Some projects may lend themselves more to quantification than others and furthermore different authors may reach different conclusions about the same type for public expenditure. The most common treatment of the non-quantifiable elements of public expenditure on education is to incorporate a statement of their expected significance (impact) in the text of the C.B.A. thereby demonstrating an awareness of their existence. Unfortunately one is still left doubting whether this is really satisfactory.

The omission of the non-quantifiable elements of electrification from the calculus of C.B.A. casts serious doubt over just how reliable the conclusions from the analysis are in establishing a social ranking of economic alternatives which reflect individual preferences and scarcities - a primary purpose of the project appraisal. It seems worth asking then, whether there are any acceptable alternatives to project appraisal as outlined, which yield a preferable social ranking of economic alternatives? What of the ballot box, political lobbying and a greater reliance on the market mechanism? Arrow demonstrated that voting does not necessarily yield a conclusive result, even if it was a viable alternative, which

it is not. A referendum or election cannot be called for every public economic decision. Nor do single votes reflect preference intensities.

Furthermore, they are usually made on the basis of general public policies rather than particular questions (Levin 1983:197).

The weaknesses of the alternatives to project appraisal do not justify C.B.A. on their own, however, De Wet (1990) in an evaluation of C.B.A. points out that it necessarily involves value judgements and believes the introduction of this normative element into the analysis to be severely damaging. His assertion is in principle valued, for even if no explicit account is made of the distribution of income, this implicitly amounts to an acceptance of the existing distribution of income.

Certainly interpersonal utility comparisons are inevitable consequences of cardinal utility justification of C.B.A. and unfortunately an ordinal utility approach using compensation criteria does not provide an acceptable alternative. As, for example, De Wet has argued, compensation is never paid to the losers and in any case, an indeterminate result is produced in the event of intransitive utility curves occurring (the Scitovsky paradox). The great weakness of De Wet's analysis was that he failed to consider the possibility that interpersonal utility comparisons may in fact be socially desirable. Therefore, rather than this being a serious defect

inherent in C.B.A., it may offer the potential for being an outstanding attribute in that distributional criteria may easily and explicitly be incorporated into the analysis. (It is however, acknowledged that the afore going argument in no way diminishes the constraining effect non-quantifiable aspects have on the C.B.A. outcomes of a particular public expenditure) (Levin 1983:229; Unesco 1977:31).

Notwithstanding the possible social virtues of incorporating distributional criteria, a position taken up by Mishan is that it remains of doubtful value. His objection is not with the hypothesis of diminishing marginal utility to increasing income, but with the deductions made on the basis of this hypothesis (Mishan 1987:102).

If an ordinal framework is adopted for analytical purposes it can be shown that distributional weighting does not remove the reversals 'problem' (or perhaps 'possibility' is a better word) which besets the compensation criterion basis for the social ranking of projects. If, on the other hand, a cardinal approach is followed, the 'crux' becomes the measurement of a marginal utility of income function. This necessarily involves arbitrariness as there is no general agreement, or is there ever likely to be, on a unique relationship between 'utils' (i.e. a supposed measure of utility) and commodities (including money).

If, as it seems then, in order to achieve the socially
desirable end of incorporating distributional weighting into
C.B.A., we have to retreat to arbitrary assessment, the logical
question which follows is who should make this assessment?
Should it be the economist based on his expert knowledge of
relationships within the economy, or, is this in fact beyond
his domain? Sugden and Willians say it is beyond his domain -
they argue that he is the 'analyst' not the normative assessor
for society. Where value judgements are involved, his function
is not to make them but to identify the activities of the
Government. What societies preferences are and to base his
weighting measures on this assessment (Hosking 1985:69).

Their rationale is really quite simple, and on the face of it
quite appealing - the economist's 'right' concern is stated to
be with the purely technical manipulation of given data to
produce consistent decisions, and the government's 'right' is
determining public policy (a function the electorate would
assuredly expect their political representatives to perform)
and thus also, the public policy parameters, such as
distributional weights and the social discount rate. Part of
the economist's role, given this scenario, would be to
interpret for analytical purposes, the dimensions of these
political parameters from the government activities. Sugden
and Williams suggest the possible guiding avenues for such
investigation - the precedent set by past government actions in
investment, the use of marginal rates of income tax based on

the belief that their determination involved the principle of
equalising the share of real burden of any incremental tax
across all income groups and most obviously, direct liaison
with the relevant policy makers. Mishan has also come out very
strongly against the use of politically determined parameters.
He does not believe that there can be any stability in their
setting with continual short-term variance being induced by
political vogue and the exigencies of state and he is doubtful
as to whether it would, in this case, be a mechanism for the
redistribution of national wealth. He contends that it is
possible that a politically determined C.B.A. could be used to
"legitimize" maintenance of the status quo or even enhance the
position of the rich.

 Such a consequence could result from the presence of powerful
'elite', lobbying representation in government. In short, he
does not believe such a system does the economist's or C.B.A.'s
reputation any good and that in particular, it erodes the
credentials of the economist with respect to his ability to
provide a valuable independent contribution to project evalu-
ation. The economist's role becomes :-

> "As the creature of bureaucracy, or the agent of
> political opinion entrusted with the task of translating
> its current prejudices into respectable looking numerals
> - it is far removed from his traditional role as an
> independent specialistdrawing his inspiration wholly from
> economic principles of valuation".

Mishan's view is however, extreme and fails to reject the 'core' issue, that is, who other than the government 'should' decide on public policy?

Another issue which has aroused considerable controversy is that of the pricing techniques used in C.B.A. For example, De Wet, basing his argument on the theory of second best, had this to say:

"We actually face quite a disheartening situation, the very need for cost-benefit analysis, namely market failure, renders the correct pricing rule to be used unascertainable".

It is a theorem of economics that given perfect competition and an absence of externalities that a competitive equilibrium can be a welfare optimum where wealth is suitable distributed. But where some of the conditions for a competitive equilibrium are not met, then the pricing rule becomes more complex. It is not as one would expect, that all changes in the direction of perfect competition necessarily bring the economy closer to a welfare optimum.

To illustrate this consider an economy where three substitute goods X, Y and Z are produced but where goods Y and Z deviate from their original costs by 10 and 20 percent respectively, although both are produced at optimal levels.

The problem is, given this state of affairs, how is "new good" X to be priced such that an optimal output of X, Y and Z is produced? Optimality under perfect competition may be obtained where the ratios of marginal costs equal the ratio of prices, but given the deviations from marginal costs, as above, the correct pricing rule for good X seems, indeed, "unascertainable".

The price at which X should be valued appears to be between 10 to 20 percent over its marginal cost if optimality is to be approached. If the price of good X was set equal to its marginal cost of production, this would involve a greater departure from the ideal position of equal price - marginal cost ratios (Zymelman 1984:105; Spain 1977:105).

Mishan feels that the impact on the rest of the economy of the single project is however, not sufficient to fear making things worse by pricing commodities at their marginal costs. Little and Mirrees justify their approach on an efficiency proposition. They contend that if public production is inefficient, this implies that a change in plans makes it possible to have more of some goods without having best of others. Given then, the not very demanding condition, that the government could distribute the 'surplus' in such a way as to give rise to an unambiguous improvement in welfare, it appears that valuation by their numeraire does not give rise to ambiguous welfare results, as implied by the second best

theorem line of attack. Graaff on the subject of the Little -
Mirrees approach, does not accept that their approach offers a
solution to domestic market distortions because international
prices are also subject to distortion, e.g. by cartel formation
and surplus output dumping (Hosking 1985:103).

The weakness of this criticism lies in its failure to
appreciate the flexibility of the Little - Mirrees approach in
accounting for such distortions.

Clearly C.B.A. has severe limitations and it is only one
consideration in a wide range of other economic, social and
political influences which must necessarily be borne in mind by
the decision maker. Nevertheless it remains an important con-
sideration for the decision maker. It not only serves to bring
all relevant costs and benefits of a project to the notice of
the decision maker (which some claim is all it achieve, e.g.
Graaff), it also serves as an indicator for the relative
economic worth of projects, even if this is within a context of
underlying value judgements, uncertainty and a margin of
imprecision in the pricing of factors and commodities.
The technique is least applicable to projects which contain
predominantly non-quantifiable elements and or, are large
relative to the economy and as such are expected to have
widespread economic impact, C.B.A. is a partial analysis and is
not suited to such situations. A general equilibrium analysis
may be recommended in such a case. It would seem reasonable to
conclude then, that C.B.A. does constitute a useful analytical

technique for guiding decision making in many areas of public
expenditure, electricity being one of them, but that every
effort has to be made by the analyst to bring the subjectivity,
uncertainty and imprecision necessarily inherent in the
results, as well as the omitted non-quantifiable elements of
the expenditure, to the attention of the decision maker (Spea-
gle 1982:198).

CHAPTER FIVE

THE ECONOMIC IMPACT OF ELECTRIFICATION

5.1.   INTRODUCTION

5.2   ENERGY CONSUMPTION IN UNDERDEVELOPED AREAS

5.3   FACTORS DETERMINING ENERGY USE

5.3.1   LEVEL OF URBANIZATION

5.3.2   SITE - SPECIFIC FACTORS

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5.4   ENERGY PROBLEMS AND SUPPLY CONSTRAINTS IN
               UNDERDEVELOPED AREAS

5.4.1   ELECTRIFICATION PROBLEM

5.4.2   DEFINITIONAL MATTERS

5.5   CONCLUSION

5.1.   INTRODUCTION

Energy use is an important factor in economic growth and development. Electricity, especially is regarded as an essential and convenient form of energy and it is easily converted into other forms of energy such as heat, light and mechanical power. As an 'indispensable' service, by reason of the absence of close substitutes, electricity assumes a position of ever-increasing importance in almost every facet of daily activity in the home, work place and community centre. Described by Christie (1984:1) as a 'spirit of progress', electricity may be viewed as the driving force behind the growth and prosperity of a modern society. It can provide the means towards better health and education, a more efficient labour market, more recreational time and greater security, all of which should help to improve the quality of life and the prospects for sustained economic growth.

Access to affordable and convenient fuels increases as households shift from rural areas to metropolitan centres, but this is constrained by the availability and cost of fuels and household income. The shift from the use of muscle power and the combustion of fuelwood in early and developing cities, to water and windpower, and then to the more energy intensive fuels, such as coal, gas oil and uranium, has determined the degree to which economic and productive activity has been able to expand.

For example, the industrial revolution in Britain was dependent on a shift to the use of coal. Growing energy requirements of the iron smelting industry were causing massive deforestation through their demand for charcoal which ultimately could not be met even if the total land area of the British Isles were covered in forests or plantations. The same could be argued for the growth of the mining industry in South Africa which simply would not have been possible without abundant (and inexpensive) electricity generation from coal.

But development has seldom been even or equitable, either between countries or within individual countries. In South Africa, these inequalities are particularly evident not only in terms of personal income but also in terms of access to basic services and needs such as food, shelter, health, education, sanitation, water and energy supplies.

Energy usage provides one striking example of processes and conditions of development and underdevelopment in South Africa with the existence of a developed energy - intensive industrial capitalist economy dependent on fossil-fuels supporting a minority of the population at a high standard of living, in conjunction with an underdeveloped sector where the majority of the population (mostly black) live in relative poverty and traditionally dependent on scarce fuelwood resources but are increasingly having to shift to the use of some of the more expensive forms of fossil fuels such as paraffin, gas, candles

and even coal, particularly in areas where they do not have access to electricity (Best 1979:213).

Patterns of energy use are thus relevant to processes of economic development, they also effect the quality of life of individual households in an immediate way. In this chapter a number of recent studies of the form and quantity of energy used by households in underdeveloped rural and metropolitan areas are reviewed and some of the key problems associated with energy supply constraints are discussed.

5.2 ENERGY CONSUMPTION IN UNDERDEVELOPED AREAS

In the energy field, underdeveloped areas in South Africa may be defined as being mainly the poorer black communities, which do not have access to electricity for domestic energy requirements. There have been a number of studies in the past decade (Best, 1979; Liegme, 1983; Gandar, 1982; Eberhard, 1984; Eberhard, 1986; Eberhard and Dickson, 1987; Black and Themeli, 1990) which have measured fuel consumption in different rural and metropolitan areas, and have documented some of the problems associated with dependence on these fuels.

Energy consumption in underdeveloped areas is almost exclusively confined to household fuel use. The breakdown of fuels used by households in homeland villages, on commercial farms, in peri-urban areas and in urban townships is summarized in Table 5.1.

Table 5.1: **Percentage of households using different fuels in South Africa 1989/1990.**

	Electricity	Wood	Waste	Paraffin	Coal	Gas	Battery
Homeland	<1	99	80	96	12	5	55
Farm labourers	14	97	30	19	5	9	–
Peri-urban	3	68	22	84	53	7	60
Townships	29	38	2	71	47	14	–

Source: Eberhard, 1986 a; Moller, 1985

The average quantity of fuels consumed in a number of representative 'homeland' villages and peri-urban areas in South Africa has been estimated as shown in Table 5.2.

The consumption data may be converted into equivalent energy values in order to evaluate the proportional contribution of each fuel to total net or useful energy consumption. Net energy is the total purchased by the user and useful energy is the amount available from the conversion appliance for cooking and heating. This topic is discussed extensively in paragraph 5.3.1.

Table 5.2:   Mean annual per capita domestic energy consumption in the RSA

	Fuel wood	Dung	Paraffin	Candles	Coal	Gas
	kg	kg	Litres	Number	kg	kg
Villages	604	118	23	27	20	966
Peri-urban	334	–	47	51	156	1,9

Source: Eberhard, 1986 a.

Figure 5.1. <u>Net and useful energy consumption for rural and peri-urban areas (GJ/cap/year)</u>

<u>Rural : useful</u>   <u>Peri-urban : useful</u>

Source: Eberhard 1984

5.3. FACTORS DETERMINING ENERGY USE

Energy consumption studies often present only a static picture of consumption patterns with very little understanding of processes of development and the factors which constrain or determine the form or quantity of fuels or how these patterns might shift over time.

5.3.1 LEVEL OF URBANIZATION

The data presented in Figure 5.1 and Tables 5.1 and 5.2 show a clear pattern of transition in energy use in relation to urbanization. As expected, the use of fuelwood (which is probably the least convenient of all fuels and is difficult and expensive to transport) declines markedly from rural areas to peri-urban areas to townships. Coal is a substitute for wood in peri-urban areas, while in black townships access to bottled gas (LPG) and electricity increases, although coal is still used extensively for heating. The use of paraffin (which is also widely perceived to be a smelly, messy and expensive fuel) increased steadily from rural to urban areas. Batteries and, in some cases, generators are used extensively by households in peri-urban areas and in townships where there is no electricity.

One of the phenomena associated with increased urbanization is the growth of informal settlements in peri-urban area around

metropolitan centres and in closer settlements within the homelands where people have settled or have been settled in or close to urban densities, but with more rudimentary facilities, and seldom with access to electricity. These areas should become increasingly important in national energy planning and investment decisions.

5.3.2 SITE - SPECIFIC FACTORS: AVAILABILITY/COST

It should be noted that while the form and quantity of energy used differs markedly between villages and peri-urban areas, individual studies by Eberhard (1986a:102) have shown that there is fairly large variation between villages themselves and, to a lesser extent, between peri-urban areas. These variations may be attributed largely to site-specific factors such as the local availability and cost of alternative fuels.

For example, fuelwood consumption is higher in those areas where natural woodland is still abundant, coal may be used in those villages close to railway sidings, and paraffin or gas is used extensively in areas closer to metropolitan centres where these fuels are cheaper and 'fire' wood is not readily available (Eberhard 1986a:102).

5.3.3 INCOME

While settlement patterns, levels of urbanization, fuel availability and cost are all important factors in determining

energy use, household income is also a key factor. Eberhard
and Dickson (1987:29) have shown that in a number of areas in
Bophuthatswana, for example, there is a clear correlation
between income and the use of substitute fuels, with coal being
used by lower income households exclusively and gas and
electricity by those with a higher income.

Lower income households spends proportionately much more of
their income on energy, and in some cases this can be as high
as 20 percent compared with a few percentage points for
wealthier families (Eberhard, 1986a:17). Procurement of
adequate energy supplies is a heavy burden for the poor.

In absolute terms, higher income households tend to spend more
on energy. However, it is not immediately obvious that they
use more energy. Figure 5.1, for example, indicates that the
net energy consumption actually declines from rural to
peri-urban areas (13,1 to 11,7). One would have expected that
with the higher levels of disposable income available in
peri-urban compared with rural areas, per capita energy
consumption would also increase (Cecelski, 1979:108).

The fact that this does not happen is explained by the change
in the fuels used. Coal, paraffin, gas and electricity can be
used more efficiently than wood and dung burnt in open fires,
and it is the greater use of these fuels in peri-urban areas
which results in little change in net energy consumption, but a
higher useful energy consumption (2,1 compared to 1,7 for rural

areas as shown in figure 5.1).

5.4.   **ENERGY SUPPLY PROBLEM AND SUPPLY CONSTRAINTS IN UNDERDEVELOPED AREAS**

The energy supply problems in underdeveloped areas centre on two critical and immediate issues.

Firstly, demand for fuelwood is exceeding supply with devastating social, economic and environmental consequences. Women, and increasingly other members of the household are involved in time-consuming and burdensome fuelwood collection trips, at ever-increasing distances from the home. Wood has to be transported into areas of greater scarcity and households are having to pay for what was once a 'free' resource. Perhaps of greatest concern is the environmental impact of woodland denudation and irreversible loss of topsoil. The national fuelwood demand/supply balance has only recently moved into a deficit situation, and will soon assume alarming proportions unless action is taken to restore the balance (Eberhard 1986a:344).

The second major problem is that the standard, most convenient and affordable domestic supply option, electricity, has still not been made available to many black townships. With increasing population and rates of urbanization, the problem of adequate household energy supply is shifting to these areas, which experience major social and economic costs as a result of

dependence on costly and inconvenient fossil fuels and batteries.

5.4.1   ELECTRIFICATION PROBLEM

A subject of growing concern, is the scarcity of electricity in the black townships around the metropolitan centres. With little access to either agricultural land or natural woodland, opportunities for the collection of 'free' fuels are minimal, nor do these households have access to inexpensive electricity. Sandwiched between metropolitan and rural areas, peri-urban areas experience energy problems quite different from either. Households are often still reliant on wood, which is mostly purchased from vendors, and are heavily dependent on the most costly, and perhaps least efficient, of cooking, heating and lighting fuels.

Electricity is the preferred supply option for households in developed urban areas, yet two-thirds of the black population living in and around urban centres still do not have access to it.

There is still widespread questioning of the appropriateness and affordability of electricity for black townships. Black households cannot afford electricity is the common refrain. However, the evidence from many studies over the past decade would appear to contradict these assertions. Once the initial extension fee has been paid, electricity is in most cases

cheaper than other fuels for cooking, heating and lighting (Rivett-Carnac, 1979:108).

Studies by Eberhard and Dickson in 1987, which have looked at newly electrified black townships have indicated that the difference in expenditure is less marked than previous studies have recorded (Eberhard & Dickson 1987:45). For a fair comparison it is important to calculate how much energy is being consumed so that the average unit cost of energy may be compared. Within individual townships, household with electricity tend to be those with higher incomes as they can more readily afford the connection fee and the cost of wiring their house. Higher income households tend to use more energy. In net energy terms electricity is always more expensive than wood and coal, and could be more expensive than gas and paraffin, depending on relative prices. At current prices, electricity is cheaper than gas, but more expensive than paraffin.

Useful energy from wood and paraffin are the most expensive. At current prices, electricity is still cheaper than gas, but in most cases is more expensive than coal. These comparisons are highly price sensitive and could change according to local price conditions. For example, electricity at 7c/kWh would be cheaper than coal costing more than 12c/kg (Department of Health,m 1977:169).

These data clearly dispel the popular myth that most black households cannot afford electricity, the truth is that those who use primarily wood and paraffin can no longer afford not to use electricity (Gervais 1987:310).

The benefits of grid electrification are not automatic, however, and many electrification schemes in Third World countries have revealed a number of unforeseen problems. Thought should be given to how the financing of electrification could be structured so as not to burden the initial consumers unfairly. Appropriate billing systems are also important to avoid confusion and resentment over how the electricity account are arrived at and to pre-empt over expenditure. The use of prewired harnesses can also significantly reduce house wiring costs (Moller 1985:122).

For electrification to be successful, it should be coupled with an integrated package of energy conservation and supply measures, including better house insulation, solar water heating, smokeless solid heating fuels from waste coal dumps and awareness programmes on ways to use electricity efficiently in the home.

Against this background, this study seeks to identify and evaluate the relative importance of some of the private and external costs and benefits of electricity vis-a-vis the other source of energy. For this purpose a survey of households in a

developing region of Katlehong was undertaken in February 1991. Some of the chief findings and recommendations from the survey are briefly outlined in the next two chapters. Suffice is to mention here that the survey region consisted of three sub-areas, Hlahatse area and Phoko area, Ramokonopi East all in Katlehong. The following section deals with definitional matters and gives some examples of the various costs and benefits normally associated with electricity supply.

5.4.2 DEFINITIONAL MATTERS

The decision of investing resources to a great extent depends on an evaluation of the costs and benefits associated with the investments.

The alternatives will differ as to the magnitude of the costs that must be incurred, the expected benefits that will be generated, the time scale of both costs and benefits, and the uncertainty or risks surrounding the project. Psacharopolous (1988:32) defines cost-benefit analysis as a technique designed by which these factors can be compared systematically for the purpose of evaluating the profitability of any proposed investment. Cost-benefit analysis is an aid to judgement, since future costs and benefits can never be predicted with certainty, particularly with respect to the likely benefits of a project, can never be completely precise. Cost-benefit analysis should take into account externalities or spillover benefits, since they spill over to the members of the

community. Externalities are hard to identify and even harder to measure. The cost-benefit analysis (C.B.A.) should also take into account the external cost that may be generated by investment. Such externalities include pollution, congestion and other undesirable side effects of certain industrial projects, as well as external benefits.

In the case of education, some have succeeded in identifying externalities, but few have been able to quantify them. An early attempt in the United States (Weisbrod, 1964:192) drew attention to the magnitude of externalities, and a recent study (Haverman and Wolfe, 1984:329) concluded that the standard rate-of-return estimates may capture only about three-fifths of the full value of education in the United States, including externalities and non-market individual benefits.
The external benefits of education cited in those studies include crime reduction, social cohesion, technological innovation and intergenerational benefits (which refer to the benefits parents derive from their own education and transmit to their children). As is well known, an externality exist when the actions of one party harm or benefit another party without any compensation or monetary reward changing hands in the process. The parties may be either consumers or producers and one or more activity may be involved.

External effects may be classified as either 'technological' or 'pecuniary'. Technological external effects entail changes in the real consumption or production possibilities of recipient

parties, and can manifest themselves in many possible ways. A 'producer-producer' externality may be defined as one in which the scale of operation in one production unit affects the output of other units, given that there is no change in their inputs of capital, labour or other factors of production.

Likewise, a producer-consumer externality occurs when the installation of street lighting reduces the incidence of crime or when leaves from the tree brings dissatisfaction to neighbours (Black & Themeli, 1990:682).

'Consumer-consumer' externalities is an individual who overloads his own supply connection and causes voltage depressions elsewhere and expose his neighbours to a serious risk of fire, electric shock, radio interferences and damage to electrical appliances. Consumer-producer effects are typified by vandals who damage substations, transformers and transmission lines. In all these cases, a negative technological externality either reduces utility or decreases productivity, depending of course, on whether it affects a consumer or a producer (Black and Themeli, 1990:682).

Prest and Turvey, (1966:192) believe that pecuniary externalities are common in a developing region characterised by large income inequalities and widespread unemployment and underemployment. These effects are brought about by a change in the demand and supply conditions facing the recipient parties, and are reflected in changes in the prices of inputs

and outputs. The construction of a new electrical power station may raise the demand for electrical appliances and boost the profits of retailers, wholesalers and producers of such appliances, thus ultimately leading to increased investment and the creation of new job opportunities.

Since these 'induced benefits' (Prest & Turvey, 1966:166) can have a significant impact on production and employment in developing regions, it is important that they be included in a realistic assessment of the social worth of a new public project.

5.5 CONCLUSION

Investment in electricity is a key element of the development process. Its importance is reflected in the growing recognition, since the 1960's, that investing in electricity provides and enhances knowledge, attitude and motivation necessary for economic and social development.

For more than twenty years, the World Bank has been lending for electrification in developing countries and experience has been accumulating with respect to the formulation of policies. This experience not only underlines the importance of electricity investment but also demonstrates the complexity of introducing tested policies so that they will make the maximum contribution to a country's development effort.

As a substitute for wood, paraffin and coal, electricity reduces damage to the environment. By being available at the flick of a switch, electricity improves productivity, because it allows users more time for constructive activities. Electricity for all will definitely enhance economic growth and prosperity. Energy supply is just one facet of the development process and redressing the inequalities in access to adequate and affordable energy supplies has to be aligned to efforts to restructure the economy so as to provide fairer access to its benefits for all in South Africa.