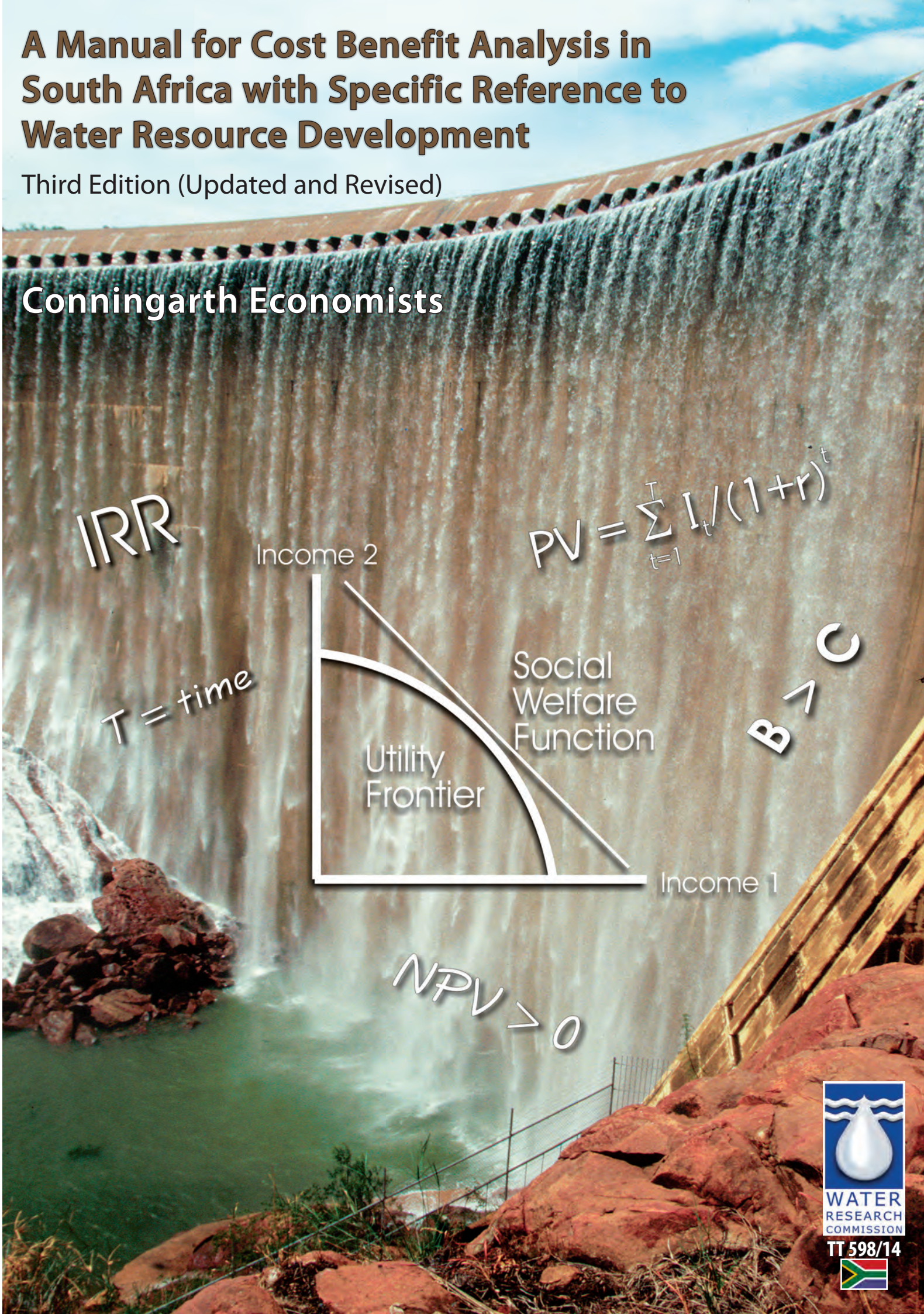
A Manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource Development

Third Edition (Updated and Revised)

Conningarth Economists



WATER RESEARCH COMMISSION
TT 598/14

A MANUAL FOR COST BENEFIT ANALYSIS IN SOUTH AFRICA WITH SPECIFIC REFERENCE TO WATER RESOURCE DEVELOPMENT

Third Edition (updated and revised)

Prepared for the
WATER RESEARCH COMMISSION
by

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CONNINGARTH ECONOMISTS

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The publication of this report emanates from a project titled *Updating of surrogate and shadow prices for the cost benefit analysis manual with special reference to water resource development* (WRC Project No. K8/1044)

ACKNOWLEDGEMENTS

In 1989, the then Central Economic Advisory Services produced the original Manual for Cost-Benefit Analysis in South Africa. This WRC Manual builds on a project which was commissioned by the Water Research Commission (WRC) in 2001 entitled: A Manual for Cost-Benefit Analysis with Special Reference to Water Resource Development (WRC Report No. TT 177/02) which was revised and updated in 2007 and published as WRC Report No TT 305/07.

This current report presents an update of the October 2007 manual to reflect 2012 prices.

It is vitally important that, from time to time, such updates are made in order to provide users of this Cost-Benefit Analysis (CBA) manual with a set of standardised, uniform parameters that will enable decision makers to arrive at sound conclusions and decisions.

The thrust of the update focused on the following aspects:

- The updating and expansion of shadow and surrogate prices to 2012 prices. It is important to provide the user with a set of standardised i.e. uniform parameters to ensure that CBA is scientifically valid for purposes of interpretation as well as comparison.
- During the recent years, the level of interest rates has decreased considerably. It is the aim of this project, as it was the case in the previous update of the Manual, to specifically look into the social discount rate, to determine whether the 8% benchmark is still valid. The level of interest rates in South Africa and worldwide has decreased and this project would provide a platform to investigate the issue of the discount rate.
- Updating the computer programme for the conversion of shadow prices for assets to 2012 prices. These assets refer, for instance types of dams, pump stations etc. This model is available in electronic format (CD) attached to the final report (See back cover).
- Updating of economic value of water for the various water use sectors;
- Presenting more recent and relevant practical examples.

It is important for users of this CBA to be aware that all other aspects of the CBA manual remain unchanged, with the exception of the above-mentioned updates. All of the underlying theory that is contained in the manual is still valid for CBA, and, as such, there was no need for these elements of the manual to be changed.

Stakeholder engagement was an on-going process throughout this specific task. Engagement was achieved through the Reference Group and through bilateral discussions with individual key informants.

The identification of the key role players in the study was based on the principle of relevance and the anticipated contribution into the study as determined by the tasks.

The following people were involved in the 2012 update. The time and effort spent by these individuals is highly appreciated by the consultants:

Dr G.R. Backeberg	Water Research Commission
Mr B. Rousseau	Development Bank of Southern Africa
Mr D. van Niekerk	Development Bank of Southern Africa
Prof A. Visser	South African National Road Agency
Mr M. Mabuda	Department of Water Affairs
Mrs A. Malan	Department of Environmental Affairs
Mr H. du Toit	National Treasury
Mr N. Dlamini	Department of Transport

The Reference Group that was responsible for the 2007 update project comprised the following individuals:

Dr G.R. Backeberg	Water Research Commission
Mr F.X. Jurgens	Development Bank of Southern Africa
Mr B. Rousseau	Development Bank of Southern Africa
Mr D. van Niekerk	Development Bank of Southern Africa
Mr P. Mabuza	Development Bank of Southern Africa
Mr I. Schutte	CSIR, Transportek
Mr G. Matras	Development Bank of Southern Africa
Mr W. Dachs	National Treasury
Dr N. Meyer	Development Bank of Southern Africa
Mr C. Chaponda	National Treasury
Mr R. Downing	South African Chamber of Business

The Steering Committee that was responsible for the 2002 initial project comprised the following individuals:

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Mr I. Schutte	CSIR, Transportek
Prof E. vd M Smit	University of Stellenbosch, Postgraduate Business School
Secretariat	Water Research Commission

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Mr F. Botes	Jeffares & Green

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ABBREVIATIONS

BCR	–	Benefit-cost Ratio
CAPM	–	Capital Asset Pricing Model
CBA	–	Cost-Benefit Analysis
CGE	–	Computable General Equilibrium
c.i.f.	–	Cost-insurance freight
CVM	–	Contingent Valuation Method
DBSA	–	Development Bank of South Africa
DCF	–	Discount Cash Flows
DWAF	–	Department of Water Affairs and Forestry
ERR	–	Economic Rate of Return
f.o.b.	–	free on board
FRA	–	Financial Rate of Return
GDP	–	Gross Domestic Product
HDM	–	Highway Development and Management
HP	–	Hedonic Pricing
I-O	–	Input-Output
IRR	–	Internal Rate of Return
JSE	–	Johannesburg Stock Exchange
LFS	–	Labour Force Survey
LP	–	Linear Programming
MCDA	–	Multi-criteria Decision Analysis
NPV	–	Net Present Value
PSA	–	Public Servants Association of South Africa
RAF	–	Road Accident Fund
RED	–	Roads Economic Decision
SADC	–	Southern African Development Community
SAM	–	Social Accounting Matrix
SARB	–	South African Reserve Bank
SARS	–	South African Revenue Service
SETA	–	Sector Education and Training Authority
SOC	-	Social Opportunity Cost
SPC	-	Shadow Price of Capital
SRTP	-	Social Rate of Time Preference
SSA	–	Statistics South Africa
STPR	–	Social Time Preference Rate
TCM	–	Travel Cost Method
UK	–	United Kingdom
VAT	–	Value Added Tax
WCD	–	World Commission on Dams
WfW	–	Working for Water
WMA	–	Water Management Area
WRC	–	Water Research Commission
WTA	–	Willingness to Accept
WTP	–	Willingness to Pay
WUA	–	Water Use Authority

EXECUTIVE SUMMARY

This report presents the guidelines in the format of a manual for conducting cost-benefit analysis (CBA) in South Africa, with specific reference to evaluating the development and management of water resources. This evaluation of projects is often a difficult task since costs and benefits do not occur only once, but appear over time. Furthermore, costs and benefits are often hidden, making them hard to identify, and are also frequently difficult to measure. The same problems occur when the decision maker has to make a choice between a number of mutually exclusive projects intended to achieve the same goal via a number of different routes. These problems are not limited to capital projects; they also occur when decisions have to be made regarding the merits of current expenditure programmes. The CBA method, also known as benefit cost analysis, provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process. This manual is specifically aimed at the decision maker in the public sector, but can also be used outside the public sector.

To ensure that this manual provides practical guidelines for the CBA practitioners the research was conducted in close cooperation with the research manager at the Water Research Commission, members of the Reference Group and Steering Committee of the project, Development Bank of Southern Africa, the Department of Water Affairs and leading CBA practitioners. As part of the process, four major workshops were held during the course of the project. At these workshops valuable inputs were given.

It is interesting to note a few highlights of the CBA Manual. For example, a broader approach is followed to incorporate the relationships between CBA and other aspects of the economy. In this regard the following aspects have been included:

- The relationship between the principles of CBA and welfare economics;
- CBA as one component of the range of decision-making support instruments;
- The equity and efficiency principles;

Thus it deals specifically with the uses, limitations and basic principles of CBA in order to explain the underlying conceptual framework to the reader.

The manual provides information for not only the analyst, but also contains insight into the CBA application possibilities for the decision makers. This information is contained in the introduction and background, which form a separate section in the document.

This manual advocates that the CBA concept needs to be widened to include the broader social costs and benefits derived from a project. Furthermore it is also accepted that CBA is only one of several instruments for evaluating proposed projects. One of the main objectives therefore was to incorporate an income

weighting system. This system provides for the recognition of some of the macroeconomic policies of the government e.g. combating poverty and promoting regional development. The impact of income distribution on CBA is specifically addressed in this manual. The fundamental point of departure is that additional incomes for lower income groups should be relatively more important than additional incomes for higher income groups.

By using different methods in estimating the real social discount rate for South Africa, Luus and Mullins (2008) found that most of these estimates range between 8.4 and 9.6 percent in real terms.

Based on historical per capita income and expenditure data for South Africa and global empirical research on pure discount rates, a Social Time Preference Rate method (STPR) of 8.35% was arrived at.

Considering that the second edition of the CBA manual is already recommending a real discount rate of 8 percent and that this rate is used in project evaluations in the public sector, it seems appropriate to retain 8 percent as the applicable discount rate for South Africa. Based on current evidence, the 8 percent discount rate would also be closer to the theoretically argued and calculated rates based on opportunity costs and time preferences.

The manual also propagates the need for sensitivity analysis. In most cases, a CBA is performed for future projects and thus entails the estimation of certain key variables such as expected prices and quantities. Although it could be accepted that the decision-maker is fully aware of the fact that the projected outcome of a project cannot be interpreted in absolute certain terms, it is important that the analyst provides the decision-maker with some idea of the degree of certainty/uncertainty to which the project outcome would be subjected to. In this regard both selective as well as general sensitivity analysis are discussed. A general sensitivity analysis hinges on the derivation of a probability distribution of possible outcomes.

As far as possible a practical approach is followed in this manual. This applies specifically to the guidelines for shadow and surrogate prices. In this regard the following shadow/surrogate prices are provided:

- Shadow wages for unskilled labourers per province
- Estimated annual remuneration for occupational categories in South Africa per province
- Index of projected real effective exchange rate of the Rand
- Index of projected prices for petrol and diesel
- Index of estimated relative changes in electricity prices
- Estimated time cost according to income groups
- Economic value of productive life

As mentioned above the focus in this manual is on evaluating the development and management of water resources. In this regard various issues relating to such evaluation are discussed. For example, attention is given to water development and river basin management cost. The subject of the opportunity cost of water is also addressed. The user of this manual is further provided with a list of environmental aspects related to water development. Methodologies to calculate the economic value of water for various water usages are discussed in detail. The researcher is assisted in the application of the guidelines in this manual by providing him or her with practical examples which appear on the website of the Water Research Commission (WRC). These examples include electricity, potable water, roads and municipal versus irrigation water schemes.

The main subjects discussed in this manual are the following:

- Applications and limitations of CBA
- Methodology
- Criteria for project assessment
- Shadow and surrogate prices for South Africa
- Issues relating to water development
- Practical examples

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 International History of Cost-Benefit Applications

Cost-Benefit Analysis (CBA) has its roots in the middle of the nineteenth century, when economists started to link the theory of consumers' surplus with the net gain of communities from government spending projects. The link between the surplus theory and the indirect third-party losses and gains from capital projects was again revived in the 1930's in the United States with the United States Flood Control Act of 1936. That CBA should start in the USA in practice is not surprising, because academic economists secured links with the US government at an earlier stage than in any other country. The earliest application of CBA in the United Kingdom was only in 1960 in respect of the M1 motorway. In 1967, the British Government officially directed its nationalised industries to adopt CBA.

The increasing interest and application of CBA in recent times can be based on two distinct factors:

Firstly, public expenditure in the developed economies has risen substantially since World War II. Furthermore, in developing countries the need for infrastructure expenditures has increased substantially, often financed by governments of developed countries and international aid agencies – requiring some "standardised" framework and method to evaluate these huge capital projects and minimise, as far as possible, the risk of failure.

Secondly, such appraisal techniques were already fairly well developed in the private sector in the form of discounted cash flows (DCFs) and also allowing for identified risks and causal sensitivities. These two factors, have given impetus to the prevailing notion that the principle of efficiency should be extended to drastically increased government expenditures.

The South African Experience

The economic and political experiences in South Africa over the past three decades or so do not differ materially from the international one discussed above. The main difference between South Africa and other developing countries is to be found in the added pressures that the apartheid policy placed on scarce national resources. Since the 1970s, government expenditure as percentage of the gross domestic product (GDP) rose constantly, reaching high levels of 30 percent. Due to direct and indirect international economic sanctions, over time, the need for economic self-sufficiency and security, forced government to channel a disproportionate amount of resources for government use. This led to large budget deficits, high inflation and declining GDP growth.

The need for some kind of framework and method to evaluate spending priorities on a more rational and systematic basis arose. With the help of the then Office of the Prime Minister's Economic Advisor, the concept and practice of CBA was steadily promoted for use in state departments with the backing of the Finance

department. In order to facilitate consistency and comparability it was decided in the mid-eighties to compile a manual for CBA. Hence the appearance of the first CBA Manual in August 1989 for restricted use in the public sector. It should be emphasised that the 1989 manual was developed by the government of the day. To a large extent that manual was prescriptive for use in the evaluation of public sector projects.

Main Features of the Manual

This third edition of the manual is again aimed at the decision maker in the public sector; but can also be used outside the public sector. Where the public sector planner usually works with concepts and criteria that usually do not fall under the rigours of the market system, use has to be made of proxies and other substitutes to simulate the workings of the market system in its "perfect" format. This is not easy because the evaluation of projects is often a difficult task since costs and benefits do not occur only once but appear over time in the future.

Furthermore, costs and benefits are often hidden, making them difficult to identify, and they are also frequently difficult to measure. The same problems occur when the decision maker has to make a choice between a number of mutually exclusive projects intended to achieve the same goal via a number of different routes. These problems are not limited to capital projects; they also occur when decisions have to be made regarding the merits of current expenditure programmes.

The following examples of proposed projects, in a much abbreviated form, illustrate the difficult tasks facing the decision maker when applying the principles of CBA:

(i) The construction of a new road (Transport)

A new road is proposed. The road will be of benefit to certain landowners/tenants and road users – in the form of savings in vehicle maintenance costs and time – while being to the detriment of other landowners or tenants. The construction costs are a further burden to the community. The road will mean air and noise pollution for some, but there is the likelihood that accidents and therefore injuries and deaths will decline. The authority concerned must consider these diverse consequences and decide whether to build the road.

(ii) Flood control-irrigation project (Agriculture)

Consideration is being given to the building of a dam in an area where periodic rains cause great flood damage. The dam can be used for irrigation purposes and will relieve periodic water shortages in neighbouring areas. Besides the high financial cost of constructing the dam, there is a possibility that the proposed dam may silt up rapidly. In addition, a bird sanctuary housing red data species will be flooded once the dam is completed and filled with water. Once again the decision-maker must consider all the advantages and disadvantages before making a decision.

(iii) A large-scale inoculation programme (Health)

A large-scale inoculation programme against anthrax is planned. The vaccine is expensive and there are additional costs connected to the remuneration of the medical personnel and the distribution of the vaccine. The programme should reduce mortality, morbidity and the loss of working time. Not only will those inoculated benefit, but also the rest of the community as a whole, because of the reduced risk of infection. However, there is a small risk of serious side-effects after inoculation which may lead to death. The decision-maker must weigh up the potential benefits against the cost and decide whether the programme should be adopted and on what scale.

(iv) Natural resource development restoration

The Working for Water Program (WfW) was a multi-departmental initiative co-ordinated through the Department of Water Affairs & Forestry (DWAF) since 1995. The main aim of WfW is to eradicate invading alien plants from rivers, mountain catchments and other natural areas to improve runoff, conserve biodiversity and improve the productive potential of the land. Although the initial emphasis of WfW was on water conservation, it has a significant environmental, economic and socio-economic impact felt mainly by very poor rural communities. In many cases, it contributes a significant proportion of the cash income of those communities and has the potential to provide members of the communities with opportunities for investment. To maximise and to identify the various projects in the WfW Program it is necessary to develop a better understanding of the full economic impact of these projects.

A CBA Model has been developed to calculate the economic costs and benefits at a project or quaternary catchment level. To capture the cost and the benefits of a specific project on a structured way the model has been developed in various components:

- Clearing of alien plants
- Use of natural vegetation
- Development of small secondary industries
- Additional water supply and costs
- Veld fire management

- Training to improve the quality of life, including improved earning potential for the local communities.

The above projects differ widely in terms of objectives but demonstrate the important principle that every project provides benefits for the community or some groups in the community, but at the same time involves disadvantages or costs for the community or some groups in the community. It is the task of the decision-maker in the public sector to weigh up the benefits against the costs in order to decide whether a project will have a net benefit for the relevant community. The CBA method (also known as benefit-cost analysis) provides a logical framework and other means by which projects such as those above can be evaluated, thereby serving as an aid in the decision-making process.

The compilers do not claim that it is the ultimate authority on CBA in South Africa. It is stated that both the theory and the evaluation systems are in the process of evolutionary development and as such are subject to further refinement. At the same time the structure is sufficiently developed to enable one to look sceptically upon anyone who wishes to deviate from the basic principles. As a result any such person or institution should bear the burden of proof and persuasion for such deviation. This is therefore the basic point of departure pertaining to this CBA Manual. Nevertheless, partly due to demand from users, it was decided that this time round somewhat more emphasis should be put on a more in-depth description and evaluation of the basic economic theory and principles underlying CBA. In Chapter 1 the theory of CBA as a sub-section of general classical economic theory is presented in more detail. In addition a specific part is devoted to other possible project evaluation methods such as multi-criteria analysis for decision making (MCDA). As indicated earlier it is not the intention of this manual to criticise the existence or inferiority of other evaluation methods as compared to CBA. On the contrary, in Chapter 1 the point is made that it is accepted that CBA has its own shortcomings.

Recent international and local experience has shown that criticism of CBA is only admissible if it can be demonstrated that alternative prescriptive procedures are in some way superior – which in reality could not yet be proven.

However, it is today accepted that in many situations in the world and also in South Africa, the scope of CBA probably needs to be widened somewhat to include the broader social cost and benefits derived from a project. Consequently, in Chapter 3 a presentation is made of how the "standard" cost-benefit practices and procedures contained in this manual can be extended to include, for example, the income-distribution and welfare effects of a specific project. It is also shown how the advent of modern analytical models, such as the Input-Output, Social Accounting Matrices (SAMs) and Computable General Equilibrium (CGE) models can be used in support of CBA. In Chapter 4 as in the previous manual, the use and composition of a capital programme for planning purposes is presented.

An important aim of this CBA Manual is to provide the decision-maker with practical guidelines and procedures to apply the CBA methodology. Based on experience with CBA analysis over the past 20 years by various development

agencies such as the Development Bank of Southern Africa, the Sector Education and Training Authority (SETA) programs of the Department of Labour and the DWAF and the WRC, the proposed standard procedures for the application of CBA are given in Chapter 5. These proposed steps and procedures are of a generic nature and will have a general applicability to all kinds of projects (capital and recurrent).

Another aim of this manual is to provide the user with an extensive and up to date data bank of shadow and surrogate prices in South Africa in Chapter 6. It is proposed that this new feature will further enhance the use of the manual. The baseline year is 2012.

Having regard for the fact that over the past number of years CBA has found extensive applications in the field of water development, it was found necessary to devote a specific chapter (Chapter 7) in the manual to this important topic. Important issues such as the opportunity cost of water and a method to calculate the economic (opportunity cost) value of water are discussed in this chapter.

Lastly, in Chapter 8 of this manual, several examples of CBA applications in practical terms for South Africa are presented with specific reference to water utilisation. These examples are the outcome of the use of the theory, principles, procedures and data bases of CBA as discussed in this manual.

The document is also accompanied by a CD. This CD contains various examples of practical CBA applications as well as a dynamic computer model to calculate shadow prices for various capital and operational costs.

CHAPTER 2: POLICY OBJECTIVES AND THE UTILITY, NATURE, APPLICATIONS AND LIMITATIONS OF COST-BENEFIT ANALYSIS (CBA)

2.1 Theoretical Foundation of CBA

2.1.1 Background

The origin of the basic theory and principles behind the practice of Cost-Benefit Analysis (CBA) dates back to the middle of the nineteenth century. The idea of measuring the net advantages of a capital investment project in terms of society's net utility gains (welfare economics) originated with Dupuit's well-known publication in 1844[1]. He started to develop his definition of what is now called consumers' surplus (i.e. the willingness to pay for a good or service over and above its market prices) as a measure of the net welfare gained from a project. This aspect of the definition of net social benefit is fundamental to CBA, and is extended to instances where persons who are not direct beneficiaries of a project obtain some form of spill over benefit. Accordingly the measurement of net social benefits requires the estimation of all the consumers' surpluses to whoever they accrue.

According to Boardman et al. [2] , CBA can be thought of as providing a protocol to measure allocative efficiency in the economy. This approach is based on the work of the famous Pareto, who formulated the Pareto optimum condition viz: "An allocation of goods is Pareto efficient if no alternative allocation can make at least one person better off without making anyone worse off"[3].

There is a direct relationship between net benefits and the Pareto efficiency. As long as all impacts are valued in terms of the willingness-to-pay concept and all required inputs in terms of opportunity costs, then the sign (positive or negative) of the net benefits indicates whether or not it would be possible to compensate those who bear costs sufficiently so that no one is made worse off. Positive net benefits indicate the potential for compensation to make the policy Pareto efficient; negative net benefits indicate the absence of this potential.

This state of affairs is sometimes also referred to as the Kaldor-Hicks criterion[4]. Important pre-conditions are that gainers must be able to compensate losers and still be better off.

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1 **Dupuit J. "On the Management of the Utility of Public Works" 1844. Translated from the French, in International Economic Papers, no.2 (London 1952).**

2 **Boardman AE. et al; CBA – Concepts and Practice, Prentice-Hall Inc. 1996 – pp 28/29.**

3 **Boardman etc., pp 29.**

4 **Sassone PG & Schaffer WA. CBA, A Handbook: Academic Press; New York 1978, p 9.**

2.1.2 The function of profits

Based on the classical theory of economics (including welfare economics) which has as its main underpinnings perfect free-market conditions with the rule of laissez-fair, profits (must) measure the gain which society derives from investment. Profits also serve as an essential signalling mechanism for guiding investment decisions. CBA in its traditional format does assume that actual receipts (benefits) adequately measure social benefits and actual expenditure measures social costs.

The traditional approach to CBA assumes that if the private capital markets in a country were perfect and if there were no taxes or subsidies at the margin on profits and income, the market interest rate would be the appropriate rate for discounting future costs and benefits. If the Economic Rate of Return (ERR) on investments equals that of market interest rates, the balance between investment and consumption at any point in time would be correct; that is, the economy would be on its optimal growth path.

If the economy was on an optimal growth path, then the objective function for the National Income i.e. (Y) can be stated in terms of the maximisation of the sum of aggregate consumption (C) and investment (I) that is national income, at any point in time. Thus maximum social benefit is simply C + I, given that changes in C are equally as valuable as changes in I. Those who use the traditional approach usually talk, not about consumption effects but about national income effects. There is no difference as long as investment is equally as valuable as present consumption at the margin – Social Rate of Return therefore equates to the ERR. This also implies a "fair" distribution of income and wealth between the population and income groups [Equity = Efficiency].

2.1.3 The use of shadow prices

In the real world, because market imperfections such as tariffs, quotas and monopolies create distortions in demand and supply, there is little chance that the market price will reflect the true economic value and cost of inputs and outputs.

To rectify this situation in order to demonstrate the real measure of efficiency with which the economy utilises its scarce resources does require adjustments to the current prices of services and commodities. These adjusted prices are referred to as shadow prices.

2.1.4 The situation in developing countries

The traditional approach to CBA discussed in the previous section, even adjusted for shadow prices, is mainly aimed at determining the economic (efficient) rate of return of a specific project. For in practice, due to market distortions, the Financial Rate of Return (FRR) of a private investment project, usually differs from the ERR. Put in another way, the FRR is not necessarily a true reflection of the most efficient utilisation of scarce resources.

One of the main criticisms against the traditional approach to CBA is that even if shadow prices are used, the impact on wealth and income distribution is neglected. [We must remember that the traditional Pareto principles use as departure point full employment and equilibrium in all markets at the margin]. For example, a 2 percent rate of growth with an even distribution of benefits is hardly the same as a 2 percent rate of growth with a highly uneven distribution. Trade-offs between growth and distribution pose important policy choices that cannot be dismissed by putting forward "trickle-down" or similar theories of the development process.

Much of the recent published work on growth and development has criticised the social valuation implicit in the traditional approach. This has led to the development of a new approach that is quite open-ended in its social valuation. This new approach does not compel one to reject the traditional view, but allows the use of different judgements. Decision-makers can use it as a flexible tool – for example, to place a greater weight on investments than implied by the traditional approach or to incorporate the objective of redressing poverty and economic inequality.

This new approach has been called "social" to distinguish it from the traditional or so-called efficiency approach.

If different fundamental objectives are selected, the valuation of benefits and costs will also differ. The shadow prices used in the new approach are often called social prices to distinguish them from the shadow prices used in the traditional approach, which are correspondingly called efficiency prices. To illustrate, the efficiency shadow wage rate will be the marginal product of labour in certain cases. The social shadow wage rate may differ, however. If the employment of an additional unit of labour in the project would increase labour income, then the social shadow wage rate would reflect, in addition to the effect on output, both the benefit of that increased income in redressing poverty and the cost of any reduced savings and reinvestment.

The main objective of the "new" approach is to bring the ERR as close as possible to the Social Rate of Return.

2.2 CBA In Relation To Other Decision Making Support Tools

2.2.1 Economic impact analysis

Whereas CBA is concerned exclusively with comparisons of direct benefits and costs to society created by an investment project, economic impact analysis examines the distribution of many secondary economic impacts and outcomes that traditionally fall outside the scope of CBA. An economic impact analysis does this by studying changes occurring across broadly defined sectors of the economy. The intent is to ascertain who gains and who loses as a result of the project, and by how much.

The types of impacts and outcomes addressed in an economic impact analysis coincide, to a certain extent, with those considered in any macroeconomic analysis. These impacts represent indirect effects on markets, rather than direct shifts in consumer or producer surpluses that are the focus of CBA. Nonetheless, these effects may have significant implications on how particular groups fare as a result of a particular project. Major categories of potential economic impacts are described below:

- Changes in economic growth and productivity: Negative impacts on regional or national productivity and economic growth can result if an investment project creates significant opportunity costs, such as the "crowding out" of investments. Alternatively, new outputs may improve the overall productivity of capital.

- Price impacts: Large projects may create a significant supply of outputs that may in turn stimulate shifts in supply or demand for related goods. During the operational life of a project for example, irrigation water supplied by a dam may affect markets and prices for substitutes (such as water conservation equipment) and, for example, equipment for higher-value irrigated crops.

- Production and employment impacts: When a project's construction requires significant capital, workers and construction materials, this may create shortages in related markets for labour and other factors of production (i.e. land, capital).

- Changes in government revenues and expenditures: If a project is financed with public funds, this may require large fiscal outlays by the government that may in turn have repercussions on the money supply, inflation, and government indebtedness. Conversely, a project located in a depressed area may boost regional economies (through household and business incomes) and generate higher tax revenues for the government.

- International trade and competitiveness impacts: If a project is large enough to increase productivity and lower the cost of production at a national level, a country's exchange rate, export position, balance of payments, and international competitiveness may improve.

2.2.2 General equilibrium approaches

Several analytical economic tools are available to assess "ripple" (secondary and tertiary market) effects on the economy of the region or country. These tools, known as "general equilibrium" models, attempt to capture the interactions of a project's direct and indirect impacts throughout the economy. Three general equilibrium approaches for assessing macroeconomic effects follow below:

Input-Output (I-O) Models. These models characterise the interdependence of sectors within an economy by generating data on multipliers and leakages. Multipliers show that the impact of a particular sector on the regional/national economy (in terms of some of the above criteria) is larger than the value/volume associated solely with that sector's output. Leakages indicate where economic impacts, such as project revenues, move ("leak") from one region or economy to another.

Social Accounting Matrices (SAMs). SAMs use a mathematically based matrix presentation to represent the flow of funds linked to demand, production and income within a national or regional economy. SAMs can be designed with a special emphasis on social rather than economic attributes (e.g. low income households) and, thereby, also provide information about equity and distribution issues. SAMs can be regarded as an extension of I-O models.

Computable General Equilibrium (CGE) Models. CGE models incorporate more realistic descriptions of consumer and producer behaviour than do I-O models and SAMs, by accounting for reactions to changes in market conditions (e.g. price). Yet their detailed breakdown of industries and commodities and regions are usually limited in order to achieve a workable model solution by approximation.

It is important to remember that CBA is not designed to evaluate macroeconomic performance. As noted earlier where standard assumptions regarding CBA, such as full employment of resources are non-existent, measuring the secondary effects may be admissible as additional welfare indicators. In this regard, projects that have regional development goals in rural areas of developing countries where underemployment may exist may wish to consider the wider economic impacts of the projects. Of course, as the objective of the project – i.e. regional development – has an inherent distributional objective, models for the evaluation of regional impacts should be considered as a tool in project planning, monitoring and evaluation in any event. [This aspect will be dealt with in more detail in Chapter 3].

2.2.3 Multi-Criteria Decision Analysis (MCDA)

Another analytical instrument for project evaluation is Multi-Criteria Decision Analysis (MCDA). MCDA aims to take into account multiple criteria to arrive at a scientific conclusion on the impact of the proposed project or program on various aspects of society. MCDA allows for the application of both quantitative and qualitative criteria. Consequently the types of key issues which are to be considered at a project or program level are not restricted by requiring monetary values.

In many policy decision-making settings there is a requirement (and practicality) to prepare supplementary assessments that are either 'stand-alone' or used in conjunction with CBA. This is particularly the case where hard-to-quantify factors need to 'captured' as part of the advice to policy makers.

In order to overcome the view (put forward by some commentators and academics, for example) that CBA relies heavily on monetary valuations and the alleged omission of factors for which money valuations are difficult or impossible, the use of multi-criteria analysis (MCDA) as supplementary (as opposed to an alternative) is often adopted. The MCDA approach is often used as a supplementary measure to CBA to examine qualitative values when assessing significant change proposals or investment decisions. There would not be any real necessity to contemplate using MCDA where it is obvious that the vast majority of costs and benefits of a proposal have been satisfactorily identified, quantified and monetised.

As touched upon in the theoretical section above (par 1.1) the theoretical origin of CBA is based on Neo-Classical economic theory. Criticism against this theory and method of determining the welfare impacts of a project is mainly directed at the fact that CBA attempts to achieve efficiency by mimicking a perfectly competitive market. Maximising efficiency does not necessarily promote equity and sustainability. By introducing the use of income distribution weights in CBA, the issue is addressed to some extent.

On the other hand the MCDA does not limit the number and nature of objectives and criteria. According to a WRC Report on MCDA, trade-offs between different stakeholders and criteria are a focus of attention[5]. In contrast with CBA, the gains to one group of stakeholders are not assumed to compensate for losses to another stakeholder groups.

The World Commission on DAMS (WCD) also advocates the use of MDCA as an alternative approach to a decision support system exclusively based on CBA[6]. In this regard the WCD "recognises that projects often have multiple objectives and not simply economic welfare maximisation. Experience to date with these multi-criteria approaches suggest that while economic criteria remain important, these decision frameworks have the benefit of allowing disaggregated information on social and environmental impacts to enter directly into the decision analysis. Such decision support systems appear particularly appropriate and useful in the case of large dams when implemented within a participatory, transparent multi-stakeholder approach.

It is not the intention of this report to present an extensive comparison between the main features of the CBA vs. MCDA. Suffice to say at this stage is that both methods have their merits and demerits depending on the nature of the project involved and circumstantial characteristics. Based on evidence up to date, there is no way that the one method could profess superiority over the other and should absolutely exclude one another. There is in any case a large degree of overlapping between the two methods/approaches. (see Stewart et al, 1997; Table 3.1).

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5 **Stewart JT. et al. Tlou; Multiple Criteria Decision Analysis: Procedures for Consensus Seeking in Natural Resource Management – WRC Report No. 512/1/97.**

6 **World Commission on Dams (WCD), Dams and Development; A new framework for decision- making, 2000. P 182.**

2.2.4 Other Practices

As can be deduced from the above, particular situations require specific approaches in terms of the format and structure of analytical frameworks and modelling. A good example is the way in which the Development Bank of Southern Africa (DBSA) does project evaluation. Based on its "Guidelines"-publication[7], the project appraisal process is conducted on macro as well as micro level and entails a number of very different types of analytical work.

In terms of the skill capacities required for integrated macro and micro-level analysis the following analyses are included by the DBSA:

- Macroeconomic Analysis – Ability to identify macroeconomic impact of projects or programs (including quantitative estimation via SAM modelling techniques where appropriate).
- Spatial Development Planning and Analysis – Ability to identify and assess spatial and community problems, needs and potential and to generate appropriate economic planning solutions. Understanding of government and civil society participatory integrated planning initiatives.
- Sector Development Planning and Analysis (where dictated by the purpose of the project) – Ability to identify and assess sectoral problems, needs and potential and to generate appropriate planning solutions. Understanding of sectoral planning initiatives.
- Project Economic Risk Analysis – Ability to identify and assess the nature of risk to the project or programme economic viability and developmental efficacy.
- Cost Benefit Analysis – Ability to conduct project or program cost benefit analysis[8].

It is interesting to note that in the CBA done by DBSA, a component is included called "inventory of non-quantified costs and benefits" which is then weighted or ranked according to their relative significance vis-à-vis its impact on welfare[9].

Lastly, regarding the application of project evaluation techniques in South Africa, reference is made to the appraisal of a skills development strategy in South Africa (SETA) [10]. Again the basic CBA was applied to estimate the economic efficiency of a SETA program. The basic structure of the CBA employed is summed up in the following example:

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7 **DBSA , Guidelines for Economic Appraisal of Projects and Programs in DBSA --2000**

8 **DBSA – report; Part A, par 6.**

9 **DBSA – Ibid.**

10 **Methodologies for the Appraisal of Skills Development strategy (SETA program) – Conningarth 2000.**

Example 1: Benefits and costs of a Human Investment Program

	INDIVIDUAL	OTHERS	SOCIETY
Benefits			
Increase in earnings after tax	x		x
Future increase in taxes paid		x	x
Non-monetary satisfaction	x		x
Costs			
Tuition costs	x		x
Costs of bursaries		x	x
Higher living expenses	x		x
Earnings foregone after tax	x		x
Taxes foregone		x	x
Transfer payments foregone	x	x	

In this way one tries to distinguish between those individual benefits and costs that reflect net social gains and losses from those that reflect only transfers from or to other members of society.

A novel characteristic of the SETA-approach is the use of certain elements of the CBA to simulate the performance of the training programmes over time. These are:

1. Increase in productivity
2. Increase in production/output
3. Increase in employment levels.

Using these performance indicators, to some extent renders the yearly conducting of a CBA unnecessary – which can be expensive and time consuming.

2.2.5 Cost Benefit Analysis as opposed to Cost Effectiveness Analysis

The key question to determine whether a cost-benefit or cost-effectiveness analysis (CEA) is used is:

Can any of the Major Benefits or Savings of the Proposed Project be quantified? If the answer is 'yes', then the evaluation should be a CBA. Only when the major benefits or savings of the proposed project cannot be quantified should a CEA be considered. The major difference between CEA and CBA is that in CEA the major benefits cannot be valued in dollar terms but only identified and quantified in physical terms. A CEA essentially compares projects and/or options in terms of their effectiveness and their cost

2.3 The Need For and Usefulness of CBA in the Public Sector

2.3.1 Background

The limited economic means and boundless needs inevitably forces government to rational decision-making in the provision of collective goods and services by spending limited funds in such a way that they more or less reflect the likes and dislikes over and above the financial acceptability of the project. CBA is a technique which can be used to determine the relative merits of alternative projects in order to reach a high degree of economic efficiency in the application of funds. It is ideally suited to the evaluation of capital projects, i.e. projects that require immediate capital expenditure but which only realise net benefits over time. CBA can also be applied to current programmes, i.e. projects that require minimal initial capital expenditure but involve costs incurred over the entire analysis period. The inoculation programme referred to in the introduction is an example of such a programme.

The efficient allocation of scarce resources should be one of the primary objectives of the public sector in its entirety. By the public sector is meant all tiers of government, e.g. central, provincial and local government as well as public corporations i.e. parastatals. Where the State is involved in large investment projects in the private sector, it is desirable to carry out cost-benefit studies because relatively large projects can influence the economic structure and price levels, as well as the environment, or they can cause externalities in the form of additional non-allocable costs to the community.

It is also possible that large investment projects in the private sector, particularly of an infrastructural nature, could result in certain social benefits, on the grounds of which the private sector can expect the co-operation of the State. Against this background it is clear that CBA techniques have a potentially wide scope of application in the public sector. It is important therefore, that, as far as possible, a uniform set of guidelines (or principles) should be laid down for CBA in this sector and that all the institutions concerned should adopt them. If this consensus is not achieved, the comparison of results becomes more difficult and there is increased arbitrariness in the choice between projects, with the result that an overall efficient allocation of resources cannot be achieved.

2.3.2 Policy objectives

In many ways public sector projects form the vehicle by which governments pursue their policy goals and express their priorities. The following fundamental considerations are at stake here.

2.3.2.1 Present and future consumption

An important objective of economic policy is the improvement of living standards, which implies the increased consumption of goods and services. As a result of the scarcity of economic resources, current consumption competes with future consumption. As a result the policy-maker should, implicitly or explicitly, weigh

current consumption against consumption at every stage in the future. Where the government emphasises current consumption, the situation will probably be characterised by relatively low tax rates and low levels of saving and investment. Should the premium be placed on deferred consumption, the opposite will most likely occur. Naturally, it is politically difficult to persuade the public to defer consumption because this is normally associated with unpopular policy measures such as higher taxation.

It is possible for a project to influence current and future consumption patterns. It can serve as a tool to encourage savings when relatively capital-intensive projects (which contribute to savings via profits and depreciation allowances) are undertaken – this is in contrast with labour-intensive projects, where the relatively higher wage payments are usually channelled to consumption. Capital-intensive projects therefore tend to discourage short-term consumption and employment, while encouraging savings and therefore growth and potential future consumption.

The value that a given community attaches to present versus future consumption is calculated in CBA through the use of what is called a social discount rate. This rate is discussed in detail in Chapter 3.

2.3.2.2 Division of consumption between contemporaries

A further important objective of economic policy is that of equity. In this case it is necessary for the planner to allocate weights to the value that consumption has for different individuals, normally grouped into certain income-groups and/or regions. These weights can be derived from the principles underlying the policy and do not necessarily have to be quantified. For example, progressive taxation systems reflect the greater weight that the planner assigns to the lower-income groups relative to the higher-income groups.

A project can serve as an instrument of income distribution in that both the geographical situation and the labour-intensity of the project are related to the redistribution possibilities of the project. In studying the distributive aspects of a project, the first problem is to determine the net benefit of a project by geographical region. Thereafter weights are assigned to the consumption that is generated in different regions, with the aim of valuing the consumption generated in poorer areas higher than that in more affluent areas. Project choices also have an influence on income distribution in that projects that depend heavily on labour (relative to capital) promote the redistribution of income over the short term.

2.3.2.3 Secondary objectives

In addition to the above-mentioned two primary objectives, there are secondary objectives which are reflected either explicitly or implicitly in a project choice.

(i)One such objective is the creation of employment opportunities, which is often seen as an objective on its own, but is essentially a derivative of the goal of equity, since it promotes the division of consumption between contemporaries. To the

extent that the creation of job opportunities goes hand in hand with political stability, such an objective has an independent right of existence.

(ii)A further objective is the achievement of economic independence with respect to certain goods or natural resources obtained from overseas. This is particularly important where the foreign supply is unstable or where it is possible that such supply could be completely cut off.

(iii) The acquisition of power and prestige is another objective which may influence project choices without consumption considerations being taken into account. In such circumstances it is particularly important for CBA to be applied so that the price which is paid for such projects in terms of the general standard of living is not hidden.

The decision-maker must therefore in any CBA consider a mixture of objectives, some of which may be contradictory. Dealing with the situation analytically is not easy, but the decision-maker should attach conceptual weights, be it implicitly or explicitly, to the different objectives involved in the optimisation.

2.4 Analytical Framework of CBA

2.4.1 The nature of CBA

The methodology set out in this document provides guidance in performing cost-benefit analysis (CBA) which is to be used for economic evaluations of water related projects and other investment proposals. Although the initial impetus for the preparation of the methodology was water related projects, this document has been drafted in such a way as to make the methodology a suitable framework in which to assess the economic merits of any investment proposal or policy change undertaken by planners and decision-makers.

When a private institution evaluates the merits of different investment options, the first step is to ensure that all the projects are feasible at the technical level. After this, the firm applies capital budgeting techniques to ensure that the project will be financially profitable, in other words that it will contribute to increasing the net value of the business. The net value is the surplus of assets over liabilities as reflected in the balance sheet of the firm. In order to contribute to the net value of the firm, it is necessary for the project to be profitable, and the firm will therefore discount the expected stream of profits and/or losses to the present time in order to determine the effect on the net value.

In the public sector (with the exception of the government business enterprises and public corporations which at least have to break even) profit is not the main objective. A variety of financial analyses can, however, be carried out in the place of profit determination. One of these, for example, amounts to an analysis of the source and application of productive resources valued at market prices with the aim of determining whether the use of the limited resources is efficient. Since the objectives of the processes of profit determination and of the analysis of the source

and application of funds differ, there are important differences between the two methods of analysis (See Section 1.5).

In the first place, with profit determination, depreciation is accounted for by the systematic write-off method because it reduces gross profit, while in the case of the source and application of funds, depreciation is not taken into account, since it affects both the source and application of funds. Secondly, income tax is included in profit determination but excluded from the determination of the source and application of funds since it does not directly contribute to a more effective or less effective application of funds. In the third place, interest payments are included in profit determination but excluded from the analysis of the source and application of funds because these do not influence the conversion of inputs into outputs, and can therefore be considered merely as a transfer payment.

There are a number of aspects, however, which are considered neither in profit determination nor in the analysis of the source and application of funds, such as the determination of the actual scarcity value of inputs and outputs and the measurement of intangible advantages and disadvantages. For this it is necessary to carry out a complete economic analysis.

However, a comprehensive economic analysis should include the following:

(i) As a starting point it is necessary to do a financial analysis reflecting the profitability of the relevant project at market prices. It should be noted that the financial analysis can, depending on the context in which it is used, refer to one or more accounting techniques, e.g. cash-flow analysis, profit determination, or the analysis of the source and application of funds. "Financial analysis" as used in this manual refers to an analysis at market prices from which present and future expenditure and income is calculated to determine the financial feasibility of a project.

(ii) The economic analysis, to determine the real scarcity value of goods and services used in the project and arising from the project; this is mainly based on opportunity-cost considerations; and

(iii) The social analysis, which is an investigation into the effect of the project on the distribution of welfare and other social aspects.

This manual focuses mainly on the economic and social analysis. The financial analysis in the broader sense is used as a fairly standard practice in the public and private sectors and this manual therefore does not expand thereon.

2.4.2 The financial analysis

For the financial analysis the calculations are done at either current or constant prices. In the case of public projects such an analysis (in current prices) normally gives an indication of the pressure the project will place on the exchequer and the degree of subsidisation it will require.

2.4.3 The economic analysis

By economic analysis is meant that the project is re-evaluated at prices which reflect the relative scarcity of inputs and outputs. The economic analysis normally follows the analysis of the source and application of productive funds, which is done at market prices. In the economic analysis, prices actually represent opportunity costs and reflect the actual economic value of inputs and outputs. The opportunity cost is the value of the best alternative application of an input or an output of the project. The market price of land, for example, does not necessarily reflect the opportunity cost of the land. Thus, when a price has to be determined, for example, for a piece of agricultural land used for maize farming but on which an airport is planned, the opportunity cost of the land is the discounted net output from the maize. The uses and calculation of shadow prices as a substitute for market prices are set out in more detail in Chapter 2.

2.4.4 The social analysis

With the help of this analysis the consequences of a project for the distribution of welfare in the community can be analysed and an evaluation can also be made of the effects on other social factors such as security, equity and the aesthetic values of the community. This aspect will be discussed later (See Section 3.4) for more detail.

2.5 The Differences between CBA in the Public Sector and Profit Determination in the Private Sector

Important differences exist between CBA in the public sector and profit determination in the private sector. The first difference to be found is the fact that private enterprise is concerned only with the interests of its owners or shareholders when profits are being calculated, while the interests of the community are the focus of CBA. The result is that a much wider spectrum of costs and benefits have to be considered than in the case of pure profit determination. Consider, for example, a new transport system which is cheaper and provides more comfortable transport for a part of the population, but entails environmental costs in the form of air and noise pollution. The latter aspects would be ignored in the determination of profits in the private sector, but will be taken into account in a CBA as part of the costs that the community must bear.

In the second place CBA differs from pure profit determination in that all variables in the latter case are measured in terms of market prices, while the economic and/or social benefits in the former case are often provided at subsidised prices so that the market prices of inputs and outputs, where they exist, often do not reflect the actual economic and/or opportunity costs and benefits. Because, as has been mentioned, CBA depends on the use of opportunity costs, market prices have to be adjusted to reflect the actual economic value of costs and benefits. The third important difference between CBA and the determination of profits as applied in the private sector is in the interest rate used in the discounting process. While the discount rate in the case of profit determination is a market related rate which reflects the cost of funds, uncertainties and risk, the discount

rate used in CBA represents the time preference of the community and is referred to as the social time-preference rate.

The most important differences between CBA as practised in the public sector and profit determination in the private sector are summarised in Table 1:

Table 1: The Main Differences between Cost-Benefit Analysis in the Public Sector and Profit Determination in the Private Sector

		CBA	Profit determination
1.	From the point of view of	Community	Shareholders
2.	Goal	Apply scarce resources effectively and efficiently	Maximise net value of firm
3.	Discount rate	Social time-preference rate	Market rate or weighted marginal cost of capital plus uncertainty and risk premium
4.	Value unit	Opportunity cost	Market price
5.	Dimensions	All aspects necessary for a rational decision	Limited to aspects of decision-making that may affect profits
6.	"Advantages"	Additional goods, services, products, income and/or cost savings	Money income
7.	"Disadvantages"	Opportunity costs in terms of goods and services foregone.	Money payments and depreciation calculated according to accounting principles (GAAP)

2.5.1 Constant vs. Current Prices

Using constant prices to value the economic effects of a project is usually sufficient for decision making. The basic decision in project analysis is whether to invest in a project. The alternative is to assign the scarce investment resources to other more lucrative investment possibilities. Moreover, it is necessary for resources to be valued at present economic prices to reflect their values for different uses or opportunities at the time when the investment decision is made.

If constant present prices are used throughout the project analysis – for future years as well as the initial year – then resources will be consistently valued at prices reflecting their value in alternative uses at present. Future economic developments will then be valued in the same unit prices as in present times. The use of constant prices is relevant both to capital from a national point of view and equity capital in particular. From both points of view the basic question to answer is: is the project worthwhile?

Another price adjustment that is required is to provide for changes in relative prices over the life span of a project. It is possible that prices of certain commodities or services will rise or fall relative to others pertinent to the project. For example, it may be foreseen that the prices of energy inputs will rise relative to the present prices for outputs and other inputs; or it may be foreseen that the price of an agricultural output such as rice may fall relative to the present prices of other intermediate inputs including labour. Where a particular price is expected to change in real terms, that is, relative to other items in the project statement, then the constant price analysis can be adjusted for this relative price change as it will affect the feasibility of the project.

2.6 The Uses and Limitations of CBA

It has already been noted that CBA is aimed at evaluating the costs and benefits of alternative investment projects or programme expenditures on a comparable basis as far as possible, especially through the use of a common measuring instrument, namely prices that are determined on a consistent basis. In this way the problem of choice is simplified since qualitative arguments for or against a certain project are backed up by numerical criteria. The main problems with CBA arise from the question of quantification. These aspects are discussed in more detail in later chapters (refer also to the theoretical discussion of CBA, Section 1.1).

The following aspects among others should be kept in mind when using CBA:

(i) CBA in reality constitutes a particular conceptual framework which can be viewed as a model, where the latter represents a simplified version of reality that can be dealt with in an analytical way. Through the application of the conceptual framework the policy-maker is forced to think through the full repercussions of the expenditure decision. This prevents people from misunderstanding each other and thus increases the effectiveness of joint decision-making, even if no formal analysis is done.

(ii) CBA is a technique used in an attempt to bring about a more effective distribution of resources with, as the criterion, the achievement of what is referred to as Pareto optimality (See paragraph 1.1.1), which indicates that at least one person in the community is better off while no one is worse off. A necessary prerequisite here is that the social benefits of the proposed project should exceed the social cost. The central role that the Pareto principle plays means that CBA is aimed at distributional effectiveness. It should also be ensured, however, that a given aim is achieved with the application of the minimal resources possible by carrying out cost-effectiveness studies. Attempts to find a single criterion which covers all the essential aspects of importance in a decision on a project have not been very successful. Where possible, therefore, the Pareto criterion must continue to be supplemented with additional criteria and additional analyses. These include performance auditing, utility studies, impact studies, operational research, systems analysis, organisational analysis, econometric studies, sensitivity analysis etc.

(iii) In general CBA is aimed at decision-making in respect of projects to be undertaken in the future and therefore involves projections and assumptions regarding future developments. This implies that a boundary of uncertainty will necessarily exist thereby affecting decisions in respect of the future taken on the grounds of this methodology. It is therefore desirable that CBA should where necessary be supplemented by the analysis of risk and uncertainty, as well as related information.

(iv) The specific criteria used to rank alternative projects should be supplemented with sensitivity analysis to show the effect of possible alterations in selected parameters.

(v) CBA is not equally suitable for all projects and therefore it is desirable to clarify the type of expenditure programmes (current as well as capital) on which CBA can be performed. Many experts believe that CBA is particularly useful in the fields of agriculture, infrastructure and industrial development, but the latest studies indicate that it can be applied to almost any field. In those fields where CBA is not readily applicable, there is a need for cost-effectiveness analyses so that the policy-maker can be sure that objectives are achieved with the use of minimal resources. Even with the field of application clearly described, the information which the analysis provides is not always sufficient for the decision which has to be made in the public sector. This is because different national economic objectives of a strategic or political nature will not necessarily always be reconcilable.

In any CBA the ranking of alternative projects or programmes according to certain criteria must be supplemented with the results of all other analyses, apart from economic and social analyses, and all of these must as far as possible be quantitatively evaluated. In addition, qualitative analyses should be done where quantification is not possible. All the impacts and consequences of a project should thus be pointed out in sufficient detail to promote "optimal" decisions concerning the project.

(vi) Unfortunately there are differences of opinion amongst experts concerning the way in which certain aspects e.g. shadow prices and the social discount rate, should be dealt with in CBA. As mentioned, the aim of this manual is therefore to bring about, as far as possible, a uniformity of approach and method between institutions in the public sector, given all the underlying limitations.

(vii) An important aspect of the application of CBA is that the secondary economic impacts of the projects under review outside the immediate sphere of influence of the project, i.e. factors such as consequences for the balance of payments or potential for employment creation, are omitted or they should be evaluated independently. In cases where such limitations apply to the field of influence, reference is made to CBA on the grounds of partial equilibrium analysis. If, however, the evaluation of the consequences is significant for the price levels, production or structure of large parts of the economy which lie outside the fields directly affected, would require general equilibrium analysis as embodied, for example, in structural econometric models, I-O models and semi-input-output models (See paragraph 1.2.1).

(viii) It must be emphasised that reliable statistics are very important for the implementation of a CBA system. Specific aspects will be spelt out in detail in later chapters.

(ix) It is generally recognised that errors may arise in CBA studies. According to Boardman[11], one must guard against self-interest when conducting a CBA. There is considerable evidence that managers systematically overestimate benefits and underestimate costs. It can therefore be more useful to make use of independent analysts to counter this type of bias.

From the discussion above it is clear that the methodology and application of CBA requires not only technical skills, but also a broad knowledge, profound insight and a clear-headed approach to problem solving. It is particularly important that the key aspects that are essential to the reaching of sound decisions should be separated from secondary information, of which note should also be taken. Exceptional expert knowledge, insight and experience are therefore required for the successful application of the technique along with complementary methodology. In spite of the limitations mentioned, no other evaluation method provides more satisfactory results than CBA.

[11] **Boardman, Greenberg, et al Ibid Chapter 15.**

CHAPTER 3: DETERMINATION OF VALUES IN COST-BENEFIT ANALYSIS

In this chapter important principles and criteria relating to the calculation of values in CBA are discussed. This includes some observations on scarce resources that can be used for the achievement of economic objectives and on the prices of such resources.

3.1 Prices in CBA

Since resources are limited, an important consideration in their application is to find optimal combinations of resources through which the net community benefit can be maximised. The values of inputs and outputs depend to a large degree on the level of development of the economy in which prices are determined. Market prices of products and services often do not reflect the real value (scarcity value) of products and services, since governments interfere in the operation of product and services markets through, for example, tariff protection, taxes or subsidies[12]. To assess the economic effectiveness of the application of resources within projects, it is, as previously mentioned, essential that the prices of inputs and outputs indicate their economic scarcity value.

Scarce resources are traded at specific prices, namely market prices. Provided certain conditions are met (see paragraph 2.1.2.4.1), prices are the best criteria upon which the allocation of resources for specific uses can be based. The assumption is that markets are perfectly competitive and that supply and demand determines the prices of inputs and outputs. When the free operation of the markets is interfered with, by for example the restriction or stimulation of either supply or demand or by price interference, market prices do not reflect economic scarcity values and the use of shadow prices becomes necessary.

3.1.1 Terminology

To prevent possible confusion it is necessary to describe the definition of shadow prices. In the literature on CBA, "shadow prices" and "accounting prices" have different interpretations. Key terminology in the cost-benefit literature related to shadow prices are therefore defined below to prevent confusion. Although the terminology may possibly not coincide with that which the reader is familiar with, it is important to ensure uniformity in concepts for the purpose of this manual.

[12] **There are other factors that also impede the free workings of the market mechanism. For example, the presence of monopolistic tendencies in industries.**

3.1.1.1 Price Year

The price year in an economic evaluation is the year in which the value of all costs and benefits are expressed. That is, the rand units represent the same purchasing power.

3.1.1.2 Selection of the Base Year

The base year is the year to which costs and benefits are discounted to arrive at a PV. The base year affects the magnitude of the reported results, with an earlier base year resulting in lower magnitude of results. When undertaking project evaluations, it is preferable to discount to the base year in which the decision to proceed will actually be made so that PV means just that.

The base year is usually the same as the price year. Generally, the base year and the price year should be the year in which the evaluation is conducted. The base year must be common to all alternatives being considered.

3.1.1.3 Treatment of Inflation and Interest Rates

It is important that the effects of inflation do not distort the cost and benefit streams. Inflation causes the costs and benefits that occur later in the evaluation period to appear higher than they should. This causes bias towards projects with later benefits.

Inflation does not increase the real value of costs and benefits; it only increases their monetary value. The monetary value of costs and benefits should be expressed in 'real terms' at the general price level prevailing in the year the evaluation is conducted, because inflation simply raises all cash values by a given percentage. Real or constant prices – prices net of inflation – are thus used in CBA. Interest payments should be excluded from the evaluation because they are implicitly reflected in the discounting process.

3.1.1.4 Relative Prices

It is possible (even likely) that the prices of different inputs used in a project may not move at the same rate, resulting in relative price changes. The expected relative price change can be accounted for directly.

If there is good reason to believe that an input is going to increase at a different rate from others, then the correct rate in period t is imputed by multiplying the input using the following expression:

$$P = \frac{(1+g)^t}{(1+p)}$$

Where:

P = relative price
g = rate of increase in the nominal price of the input
p = general rate of inflation (e.g., CPI)
t = time interval.

If differential rates of inflation are expected for individual cost or benefit items, the difference between the expected value of the costs and benefits needs to be included. Where cost or benefit items are expected to increase at a rate greater than general price inflation (e.g., as typically measured by the Consumer Price Index – CPI), then they should similarly be adjusted upwards. This may occur with wages or civil construction costs, for example.

If there is a situation where the analyst has strong evidence to believe that a particular category of costs or benefits is highly likely to grow at a rate 'over and above' general inflation (e.g., CPI), there is a risk of underestimation of effects in the economic evaluation. The use of a Delphi technique session could be useful here in soliciting the views and/or experience from relevant experts or gaining 'direction' to appropriate statistical or other data.

The approach recommended is to increase the particular cost and/or benefit stream(s) by the difference between CPI and the expected rate of change (which may vary over time also) prior to discounting. Obviously, where adjustments are significant, sensitivity testing will become an important consideration. Where this approach is taken for any category of cost or benefits, there should be sufficient supporting documented evidence provided in the CBA report to show the rationale underpinning the approach being adopted.

3.1.1.5 Market prices

Market prices are those perceived prices at which products and services trade, irrespective of the level of interference in the market, e.g. the market wages of labour, the price of 2 kg of maize meal, the price of 1 kilowatt-hour of electricity, etc. In theory, market prices are indeed manifestations of the willingness to pay.

3.1.1.6 Shadow prices

Shadow prices are the opportunity costs of products and services when the market price, for whatever reason, does not reflect these costs in full. Examples are shadow wages of labour where the fact that minimum wages are fixed, is taken into account, a shadow price for fuel where taxes and subsidies are excluded, the marginal cost of generating 1 kilowatt-hour of electricity, etc.

3.1.2 Accounting prices

Some writers use "social accounting prices", or "accounting prices" for short, as a substitute for the shadow price concept when a specific type of shadow price is referred to. The shadow prices used in the new approach are often called social

prices – because of additional endeavours to "adjust" shadow prices to better reflect social costs/benefits. In the rest of this manual the original definition of shadow prices is referred to.

3.1.2.1 World prices

The world price is the cost-insurance-freight (c.i.f.) price of imported or locally produced products or services that are internationally traded and that are locally consumed in South Africa. The f.o.b. (free on board) price is used for exported products or services. These prices reflect the opportunity cost of products and services when the possibility of international trade exists. The c.i.f. price of imported capital equipment and the f.o.b. price of exported iron-ore or deciduous fruit are examples of world prices. It is important to consider the transport costs of imported products up to the point where the product is economically applied.

3.1.2.2 Shadow exchange rate

The shadow exchange rate gives the future value of the rand relative to other currencies when there is no intervention in the foreign exchange market through, for example, the pegging of exchange rates or limits on capital flows. The shadow exchange rate is therefore the nominal exchange rate adjusted for the effect of interventions[13].

In this manual an adjustment to the future effective exchange rate is recommended. This adjustment is to make provision for the change in relative prices of imports and exports. This is necessary to specifically provide for the fact that the South African exchange rate does not follow the trend of the buying parity theorem. According to this theorem the exchange rate will behave according to the difference in the South African inflation rate and that of its major trading partners. Over the long term the Rand is, however, depreciating faster than the relative difference in those inflation rates.

3.1.2.3 Surrogate prices

Surrogate prices are used to value costs and benefits when no market prices exist or where no market price can be determined. Examples are the value of time and the value of a human life. The prices can be determined with the aid of the willingness to pay principle and other products or services of a similar nature. The price of, for example, clean air can be derived from what the community (as represented by the State) is prepared to pay for combating air pollution.

Surrogate prices for water are discussed in Chapter 7.

[13] This adjustment is in line with the United Nations Industrial Development Organisation, where the adjustment factor roughly equates the level of protection in the economy – Guide to Practical Project Appraisal; Social Benefit-Cost Analysis in Developing Countries. Unido, Vienna, 1986, pp 46.

3.1.3 Use of shadow prices

3.1.3.1 General considerations

In practice, shadow prices should be used in CBA only when the market prices of products and services clearly do not reflect their scarcity value or economic contributions. In cases where market prices give an accurate indication of the scarcity of products and services, market prices are used not only in the financial analysis but also in the economic analysis.

Under circumstances where the effectiveness of projects is not reflected by market prices, project input and output prices should be adjusted. Examples of these are where the market mechanism does not equate the marginal cost and marginal revenue of products and services or where serious structural imbalances exist in markets. The decision to use shadow prices will be influenced by the likelihood and consequences of the wrong use of market prices. A reasonable knowledge of the relevant economy is therefore a prerequisite for responsible price choices in CBA.

The calculation of the shadow prices of products and services is often difficult and is further complicated because it may be necessary to calculate shadow prices on a regional basis, since structural imbalances may exist between regions that are not reflected in market prices.

3.1.3.2 Regional considerations

CBA is usually used to evaluate the effectiveness of projects undertaken within a specific national economy. Furthermore, the distribution of income between different population groups, income groups and regions is affected in this way. Regional differences in costs and benefits are indeed very important when the effectiveness of projects is researched and the distributional consequences are assessed.

From the above it follows that when market prices are used to value resources they should reflect the value for different regions. In cases where market prices are not acceptable, shadow prices should reflect the value of resources for the region where they are purchased. The same applies to surrogate prices.

In order to consider the above aspects correctly in project evaluation, it is necessary to investigate the political aspects which influence shadow and surrogate prices.

3.1.3.3 Political aspects and shadow prices

Political ideologies, objectives and choices to a large extent determine the nature of community costs and benefits and the way in which they are maximised, and influence, amongst other, the following:

(i) the social time preference rate;
(ii) the value of capital;
(iii) market prices;
(iv) job opportunities and wages and consequently the value of recreational time;
(v) the value of externalities, e.g. noise and damage to the ecology; and
(vi) the income distribution and regional weightings.

Political considerations therefore constitute an integral part of the decision-making process. The analyst is therefore forced to specifically take them into account when analysing any project.

3.1.3.4 Conditions for the use of shadow prices

It is important to distinguish between the generally valid conditions for the use of shadow prices and the conditions specific to the use of shadow prices in South Africa.

3.1.3.4.1 General conditions

An optimisation process presupposes limited resources. The economic problem is to find that combination of resources that maximises some specific objectives. Scarce resources are traded at specific prices. If certain conditions are met, the price mechanism is the best way in which scarce resources can be allocated to those who will use them to the maximum social advantage. These conditions are that –

(i) the prices of final consumption goods should reflect their social benefit (value); and
(ii) the prices of scarce resources should give an indication of relative scarcity (costs).

Provided both conditions are met, supply and demand in the goods and factor markets will tend towards equilibrium. As has been argued, however, disturbances occur in practice which result in market prices not being true measures of scarcity, and this should lead to the use of shadow prices.

3.1.3.4.2 Pre-conditions for the use of shadow prices in South Africa

In order to apply CBA effectively in South Africa it is important to keep in mind the limitations under which shadow prices are used. At the same time it must be remembered that shadow prices are a prerequisite for responsible expenditure decisions. To ensure that shadow prices are used appropriately, it is necessary that:

(i) South Africa should be viewed as a constitutional entity, with the reservation that regional and local objectives should be included in project assessment as long as this can be accommodated within the broader political objectives;

(ii) a list of advantages and/or disadvantages should be drawn up and allocated to those communities who are to benefit and/or be adversely affected before any attempt is made at quantifying or analysing;

(iii) the financial costs of projects be allocated to the principal i.e. owner that is investing, irrespective of the origin of funds;

(iv) costs and/or benefits be allocated to those stakeholders who are to benefit and/or be adversely affected, irrespective of who the investor, donor, lender or principal for project analysis is; and

(v) apart from the analysis implied in (i) to (iv), every CBA undertaken should be done from the view of the whole of South Africa in order to prevent any unnecessary duplication of projects. Under some circumstances the principal may feel that the cost-benefit study should be applied to the whole of Southern African e.g. Southern African Customs Union and/or Southern African Development Community (SADC).

3.2 Principles in the Calculation of Shadow Prices

There are a number of important approaches relating to the way in which shadow prices ought to be calculated. The first can broadly be called the world price approach and the second the opportunity cost approach. The opportunity cost approach refers to the marginal social cost and marginal social benefit of a commodity. The marginal social cost in terms of shadow prices, is the value of the resources required to produce an extra unit of the relevant commodity. On the other hand, the marginal social benefit reflects the benefit evaluated in social terms derived from supplying an additional unit of the relevant commodity in the economy.

A third important approach rests on the willingness of the community or groups in the community to pay for goods or services. The first two approaches form the basis of shadow price calculation while the willingness-to-pay approach is only a method of calculating the marginal social benefit or cost.

3.2.1 World Price Approach

The world price approach takes into account world prices of products and services, especially with regard to those goods that are freely traded on international markets. Important examples are mineral and agricultural products for which active free international markets exist. Where local market prices are distorted because one or more of the conditions discussed in paragraph 2.1.2 is not met, the relevant world price serves as the shadow price after adjustments have been made for costs in the import and export of goods. This approach is not always reliable, however, because governments often peg currencies at artificial levels that do not reflect their scarcity value. Adjustments are then required in the value of the currencies. However, not all inputs and outputs can necessarily be converted to an appropriate currency value. For example, labour is one of the

most important inputs in developing countries, but there is no free international market making it possible to attach a currency value to surplus labour.

3.2.2 Opportunity Cost Approach

The opportunity cost (marginal social cost) approach uses, as the shadow price of production inputs, the production that is given up elsewhere by withdrawing these inputs from their alternative use. On the other hand, for the shadow price of outputs (marginal social benefit), the additional incremental benefit achieved by undertaking the project, relative to the situation had the project not been undertaken, is used. In this way an attempt is made to accentuate internal considerations in order to find a reliable measure of the acceptability to the community of projects.

According to UNIDO[14] the following should be taken into account:

"A central issue in shadow pricing is whether a good is "tradable", that is, can it be imported or exported? If a good is tradable, the international market-place offers an option to domestic production and consumption and thus a measure of its economic opportunity cost or its "real" value to the country in terms of pure efficiency."

In line with this approach it is therefore recommended that where projects substitute imports or promote exports, the world price approach is adopted. Locally purchased inputs are valued at international prices where the possibility exists that they could be imported or exported. The inputs for which no international prices exist are valued at the local opportunity costs.

In practice it seems that the following line of reasoning is applicable[15].

Impact	:	Basis for shadow pricing
Consumption within in the economy	:	Marginal social benefit (consumer willingness to pay)
Production within the economy	:	Marginal social cost of production
International trade	:	World prices

3.3 General Problems with the Determination of Shadow Prices

Shadow prices should be determined as scientifically as possible so that different project evaluators can achieve the same results. Therefore, it is important to take a stand on how externalities, inflation, taxation and subsidies, the project life and the value of the relevant currency should be dealt with.

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14 **UNIDO-publication. 1986. p 22.**

15 **For a summed up version of this approach, see UNIDO-publication. Ibid. p. 22.**

3.3.1 Externalities

Externalities are the effects of a project on the environment, ecology or general standard of living of a community which are not reflected by the prices of inputs or outputs. Externalities are difficult to include in project assessment because they cannot be directly allocated to the project and furthermore are difficult to quantify. The requirement that prices of products and services should reflect their relative scarcity value on the basis of all costs and benefits continues to apply, however, and therefore externalities should be considered in the analysis of a project. For example the cost to the community of polluted air can be approached by using the degree to which government is prepared to bear the cost of eliminating air pollution as a measure of the community's willingness to pay for clean air. Where it is suspected that a project will produce some form of externality this aspect should be carefully investigated.

3.3.2 Inflation

The objective of a CBA is to measure community advantages and disadvantages after the relative scarcity value of project inputs and outputs have been taken into account. However, inflation, the continued rise in general price levels, makes the determination of relative scarcity values more difficult. Inflation is not taken into account in the economic analysis and all evaluations are done in base year prices with allowance for relative price shifts. (The financial results of profit-orientated projects viewed in nominal terms, on the other hand, are affected by the inflation rate, and the internal yield rate will have to be at least equal to, but preferably higher than the inflation rate to ensure that the project continues to exist. Alternatively the net present value of the project must be positive when costs and benefits are discounted by means of the inflation rate.)

3.3.3 Indirect taxes and subsidies

Taxes and subsidies influence the optimal application of production factors and the analyst will have to take these into account indirectly when he/she forecasts the combination of inputs that will apply after the implementation of the project. It is not, however, easy to deal with indirect taxes and subsidies in CBA.

From the point of view of the economy as a whole, indirect taxes and subsidies are transfer payments, and when new inputs that have to be taxed or subsidised are looked at in the national interest, the value is calculated from the point of view of the producer by subtracting taxes and adding subsidies. When the impact of a project on a particular area is considered, however, the effect of indirect taxes and subsidies on the local economy also has to be taken into account. In such a case the market prices, including the taxes and after subtracting the subsidy, indicate the social marginal value of the input or benefit. The tax loss or subsidy gain of the region should be shown as a redistribution effect to or from the overall authority respectively.

It must be kept in mind that certain "taxes" added on to prices should be taken into account as part of the project cost. An example is where a component of a certain tax can be viewed as a user's charge e.g. the fuel levy for the building of roads.

Sometimes uncertainty arises with regard to surcharges which are levied for specific purposes, which in reality serves as a consumer charge. The general point of departure here is that in circumstances where tax would normally be subtracted, all taxation (even taxes that serve as user charges) is subtracted from market prices to calculate the scarcity value, and that a cost-element is added for the use of the input. Where it is very difficult to impute the value, the analyst can consider keeping the relevant tax in the price as an estimate of the user charge. For example, part of the tax on petrol serves as a user charge for the use of roads. The analyst can consider not subtracting this tax from the price of petrol so that it can serve as an estimate of the damage to existing roads that results from a project.

All direct taxation (e.g. income tax) and indirect taxation is included in the financial analysis, but direct taxation is not taken into account in the economic analysis and indirect tax is to be dealt with as set out above.

3.3.4 Project life

The project life is equal to the expected economic life of the project, which means that the analysis period will vary from project to project. As is well-known, many factors have a determining influence on the decision of how long the economic life of a particular project would be. This decision would obviously have a crucial impact on the outcome of the CBA calculations. One important factor that will determine the economic life and results of the CBA, is the expected growth of the benefit stream over the time horizon chosen for the project. For example, the future demand for irrigation water in a particular area will be determined by the expected demand (locally and overseas) for the agricultural products made possible by irrigation. Various methods exist by which such demand forecasts can be made; of which macroeconomic forecasting models are explicit examples.

Any assets which may remain at the end of the economic life of the project should appear as a residual item and be imputed either as a positive or negative impact on the cost stream.

In most cases it will be possible to sell the residual part of the assets for a positive amount. This value should be subtracted from the cost stream.

In some cases, however, there is a cost involved to get rid of the assets. For example, in the case of the closing down of an open cast coal mine, the rehabilitation cost involved should be brought in as an add-on cost.

In the CBA calculations one should also take into account a situation where the economic life of some assets could be shorter than the analysis period. In such instances the capital expenditure should be repeated for the relevant year.

3.3.5 Currency

The price of any imported product or mineral is converted by means of an exchange rate to internal price levels. Irrespective of restrictions on the flow of capital, the rand is fairly representative of the forces of supply and demand as determined by imports and exports and is therefore used as the shadow price of currency. It has already been argued that in the absence of free currency markets, the exchange rate does not necessarily reflect the scarcity value of a currency and that it will therefore be necessary to determine a shadow exchange rate by some other method. For this the purchasing power parity or currency-cost-approaches can be used. Since the use of these alternative approaches is not recommended, they are not discussed any further.

Because of the volatility of the exchange rate it is essential that exchange rate calculations are combined with sensitivity analysis.

3.4 Valuation of Inputs and Outputs

The sources (or production means) are the scarce factors that are needed in the production process and that lead to the supply of goods and services by the private sector and government. The discussion that follows concentrates on general characteristics of sources and the determination of their financial value (market prices) and the shadow prices.

During the production process, project inputs are transformed to outputs. The most important project inputs are capital, raw materials, labour and purchased services. Price information is usually available at market prices, but, as has been mentioned, the use of shadow prices is sometimes necessary.

3.4.1 Capital goods

Capital goods are those production inputs that are not consumed in one or two years in the production process. For the purpose of this manual they are divided into land, buildings and machinery, equipment and transport equipment. Capital goods are usually viewed as the fixed assets utilized in the project. Capital goods, like any other product, can be subject to imperfect market conditions which result in the market price not reflecting the relative scarcity of the product. Therefore it is necessary to investigate the valuation of these production means for possible incorrectly determined prices.

Normally capital expenditure takes place at the start of a project. This may also, however, occur during the economic life of the project and it may even be necessary to replace capital goods during the life of the project. The residual value of capital goods at the end of a project should be written back as a negative cost.

However, it could also be a further cost if regarded as an externality (for example in the case a rehabilitation requirement at mines).

The following table is provided to assist the researcher to take into account the replacement of capital goods during the life time of the project as well as to estimate the residual value[16]:

Table 2: Replacement of Capital Goods

Type of asset	Sector	Lifetime years
Residential buildings		50
Non-residential buildings		50
Construction works	Agriculture	80
	Mining	30
	General government*	80
	Other	50
Transport equipment		8
Machinery and other equipment	Manufacturing	8
	Mining and electricity, gas and water	16
	Other	10

3.4.1.1 Land

Land can be used in the economic process in a number of ways, e.g. as agricultural land, an industrial input or the basis of infrastructure creation. The market price of a given piece of land cannot simply be accepted as a measure of its scarcity. The inherent value of land is dependent on its physical characteristics, the climate, and the production technology applied to it. The shadow price of land is based on its opportunity cost, in other words the optimal alternative use. In order to calculate this price, the following information should be available.

(i) The historical use of the land and the value of the output derived from it in the past;
(ii) Other developments in the area which can affect it; and
(iii) Information concerning the proposed use of the land and the output from the alternative application.

It is important to remember that the expected return of any project is determined by prices which most probably reflect interventions and imperfections in the past and will manifest itself in the economy for the duration of the project. Therefore the expected return should be adjusted so that the economic value of the land can be calculated in terms of the economic value of the production given its optimal (most efficient) application.

An example can illustrate these aspects. The Department of Transport has to decide whether a local airport should be retained and upgraded or a new airport developed. An opportunity cost of nil (besides maintenance costs) is allocated to the existing runways on the grounds that there are no other uses for the runways and that their scrap value is zero. The land surrounding the airport does,

[16] **SARB, 1999, South Africa's national accounts 1946-1998, An overview of sources and methods, p. 9.**

however, have alternative uses in the form of low quality agricultural land, housing, or even industrial applications which should be taken into account.

3.4.1.2 Buildings

Buildings are essential to protect the production process from the ravages of nature and as such are included in any CBA. In order to determine economic prices, the following information may be useful:

(i) The date when the building was bought or built;
(ii) The current construction i.e. replacement cost of an equivalent building and the book value of the building; and
(iii) Alternative applications of the relevant building.

The shadow prices of existing buildings are calculated on the opportunity-cost basis and that of new buildings on the basis of construction costs. Where construction costs serve as a basis for these calculations, adjustments have to be made for possible distorted labour prices which serve as an input, as well as possible tariff protection on any locally purchased material inputs.

3.4.1.3 Machinery, equipment and transport equipment

Machinery and equipment are not usually consumed immediately in the production process. Except where they are destroyed by natural phenomena or man-made disasters, the machinery and equipment becomes obsolete as a result of wear and tear and the availability of improved production technologies. Depreciation on machinery and equipment is never, however, reflected directly in any CBA. Depreciation is taken into account indirectly in that the initial cost of the fixed assets normally appears at the beginning of the analysis period and the scrap or residual value appears as a credit at the end of that period.

The shadow price of machinery and equipment is determined in the same way as that of raw materials (see paragraph 2.4.2) by making a classification in terms of –

(i) Machinery imported, with and without any restrictions on quantity and price; and
(ii) Machinery purchased locally or made by the contractor of the project.
(iii) Where equipment is leased or where machinery is carried over from other projects to the proposed project, the use value is shadowed for labour content, tariff protection, other indirect taxes and subsidies.

3.4.2 Raw materials

Raw materials are found in a variety of formats and are converted through a variety of processes, by the addition of labour and capital into goods and services. The opportunity cost (scarcity value) of a raw material, and consequently the shadow price of the raw material, depends on a number of factors.

(i) Where a country is richly endowed with a raw material but the raw material is a diminishing asset, e.g. coal, it cannot simply be accepted that the market price reflects the relative scarcity of the asset, since the Government may influence the price for other reasons, e.g. in order to achieve a better balance of payments position.
(ii) Monopolies or cartels are in a position to force up the price of the raw material artificially to a level higher than its scarcity value.
(iii) The subsidisation or taxing of the use of raw materials will distort the prices so that they no longer reflect scarcity values.
(iv) Rationing restricts the demand for or supply of certain goods and distorts the market prices so that the economic value is not reflected in the price.

For discussion of the shadow price of raw materials it is necessary to identify three possibilities.

(i)Where raw materials are imported without tariff protection or purchased locally, the market price, which by definition is the world price plus freight and insurance (c.i.f.) to the point of consumption, is used in the economic analysis. In the case of quotas which increase the price of the imported product on the local market the same approach is used, in other words the shadow price is equated to the c.i.f. world price of the product. If government interferes with the operation of the currency market, however, adjustments should be made in the exchange rate (see paragraph 2.3.5).

(ii)Where raw materials on which import tariffs are applicable are imported or purchased locally, the shadow price is calculated by subtracting the percentage tariff protection from the local price. In the case of quotas the c.i.f. world price approach is used.

(iii)Where raw materials are purchased locally and these raw materials are not normally traded globally without influencing the local price or the local availability of the raw material (e.g. bricks) it can be accepted that the scarcity value of the product is reflected by its market price, adjusted for indirect taxes and subsidies.

3.4.3 Labour

Labour differs in many aspects from other production factors. In South Africa, for example, it is possible that there can simultaneously be a shortage of skilled labour and a surplus of semi-skilled and unskilled labour. At the same time certain factors apply to the labour market which results in the labour wage not reflecting relative scarcity. One such factor is the fixing of minimum wages (through the pressure from trade unions and/or government policy), which forces the wage above the marginal product of labour and thus restricts employment. All factors that cause the price of labour to deviate from the marginal product of labour should be considered in a CBA.

The following approach for determining the shadow price of labour is proposed.

(i) Where unemployment does not exist, the market price of labour is used for all labourers. If the quality of a specific category of labour within a sector is homogeneous and the market operates fairly freely, then the average wage of that category in that sector can be accepted as reflecting the market price in the relevant sector. Under conditions of full employment, and especially where skilled labour is scarce, this method will probably underestimate the opportunity cost of labour, but in the absence of specific information it is not normally possible to calculate it more accurately.

(ii) For a worker who has very poor technical skills and who lives in a region where unemployment exists, the income per earner in the region is used as a measure of the production lost (shadow wage) when the worker is employed. Such income is usually lower than the minimum wage and is a more correct reflection of the opportunity cost of labour. The minimum wage is artificially set too high as a result of the power of trade unions and social pressure.

3.4.4 Services

Purchased services are not always concrete or visible in the final product of a product or service that is produced, but nevertheless form an integral part of the product or service, e.g. electricity, gas, water, transport, promotions, advertising and research and development. The opportunity cost of a service is the value that the remainder of the community has to forgo if they are denied the service or the cost imposed on them to deliver the service. If, for example, a project needs electricity, the shadow price of the electricity in a given region will be equal to the long term marginal cost of provision. The same approach applies to the cost of water, gas and transport.

3.5 Surrogate Prices

3.5.1 Advantages and disadvantages not reflected by a market

Some intangibles have a value but are not tradable in a market. Examples are the value of time or a human life. In order to determine the value of these the following approach is recommended:

In determining the value of time a decision has to be made as to whether the valuation is done in respect of working time or leisure time. The value of working time is theoretically equal to the marginal productivity of labour, and in a perfect labour market it would be reflected in ruling wages. It must be noted, however, that wages are not paid only for the free time that has to be given up to work, but also for the exertion required. Therefore the value of free time is equal to the ruling wage less the compensation for the working effort. Where free time is saved as a result of faster transport, the value must be increased or decreased in order to take into account the value of travelling pleasure, or the productive application of travel time, or the unpleasantness of the journey. In practice it is difficult to deduce the value of free time from the value of working time by means

of this approach, and it is customary to estimate it in an empirical way by means of observations of time savings and related expenditure.

The accurate estimation of the value of working time by analysing wage packets for those involved on a sample basis and by conducting surveys to derive the value of free time is necessarily a time-consuming process, but it is essential where the results will be of critical importance for decision-making. Where the value of time savings for the general public is included as one of the benefits of a project, it is normally sufficient to accept the average per capita income per time unit as representative.

In determining the value of a human life, the economically productive life of an individual must be calculated in order to determine the lost production caused by death. The consequences and costs of injuries and, if the injury is temporary, the lost production attached to it, must also be determined.

This is not, however, the only method for determining the value of a life. Thompson (1983) [17] also refers to the Pareto method, the consumption-value method, the value according to potential earnings, the willingness-to-pay method and the social value method. According to him the last method is preferable, but the lost production method is most often used in practice.

3.6 Alternative Approach

In some cases the benefits are difficult to quantify in terms of market prices or even surrogate prices. The benefits should therefore be valued by calculating the saving between the situations after the project is completed and the situation before it was started. If the costs with the project are lower than the costs without the project then the project provides benefits for the user. The opposite is true where "without-project" costs are lower than the "with-project" costs. This analysis is known as incremental benefit analysis and it calculates the incremental saving that a project brings about. An example of this is the benefits of an e-mail service relative to fax machine, where communication resulted in a higher labour content.

[17] **Thompson MS. 1980.** ***Benefit Cost Analysis for Program Evaluation.*** **London: Sage Publications.**

CHAPTER 4: CRITERIA FOR PROJECT ASSESSMENT

After completion of the financial and economic analyses, every project should be assessed individually in order to determine whether it will increase community welfare. Regarding the composition of a capital expenditure programme, the projects should be ranked in priority order in terms of financial and economic criteria. In this chapter the project assessment criteria are discussed systematically and an indication is given of the most suitable criterion to use under certain conditions. This is followed by a discussion of sensitivity analysis and income distribution measurement. The composition of a capital expenditure programme is discussed in Chapter 4.

4.1 Definition of Terminology

4.1.1 Mutually exclusive and independent projects

By mutually exclusive projects is meant alternative methods of performing the same task or reaching the same goal. For example, if the aim is to protect vehicles against weathering, a variety of alternatives can be considered. Eventually, only one of the alternatives will be chosen. The economic assessment of mutually exclusive alternatives therefore involves choosing the most cost-effective alternative.

Independent projects are completely unrelated and more than one of the projects can be carried out. In fact, it is possible to carry out all independent projects when there is no shortage of funds. Examples of independent projects are the construction of a new highway between towns A and B and the construction of a bridge between towns C and D. Where funds are scarce, however, it is important to rank the projects in order of acceptability so as to determine which projects should enjoy the higher priority. Even if it is possible to finance all the projects, it is still important to have criteria that can be applied to ensure that each project is in the interests of the community.

Logically speaking, projects are assessed in a predetermined order. The mutually exclusive projects are usually assessed first to find the most cost effective alternative, after which the chosen project competes for funds with other projects, which are chosen in the same way (all independently of each other), in a second assessment phase. The most effective alternative in a particular situation is not necessarily the best project when a programme is initially being compiled (See Chapter 4).

4.1.2 Discounting

Discounting – what is it and why do it. Discounting is the reverse of adding (or compounding) interest. It reduces the monetary value of future costs and benefits back to a common time dimension – the base year/date.

Discounting satisfies the view that people prefer immediate benefits over future benefits (social time preference) and it also enables the opportunity cost to be reflected (opportunity cost of capital).

Costs that are immediately incurred and benefits that are gained in the present time are judged differently by the community from costs and benefits that materialise over a period of time. The community would rather prefer to receive a benefit today than in the future, while deferred costs are more attractive than immediate payment. Therefore the money value of costs and benefits over time cannot simply be added together; the time preference of the community has to be taken into account through the use of a weighting process. This weighting by the community is done with the aid of a rate that reflects the value of a benefit or cost over time. It is known as the social discount rate.

Suppose b0, b1, …, bn are the project benefits in years 0,1,2, …, n and c0, c1, …, cn are the costs in years 0,1,2, …, n, respectively, and i is the social discount rate, then the present value of the benefits is given by

$$b0/(1 + i)0 + b1/(1 + i)1 + \ldots + bn/(1 + i)n$$

and the present value of the costs are given by

$$c0/(1 + i)0 + c1/(1 + i)1 + \ldots + cn/(1 + i)n$$

The analyst needs to determine the following when preparing to undertake the Discounted Cash Flow (DCF) aspects of CBA:

- The appropriate price year for cost estimates and the level of prevailing inflation
- Whether analysis of relative prices is necessary for some cost items (e.g., labour costs)
- What the base year (or discount year) is to be
- What is to be the base/initial evaluation discount rate
- The evaluation period (or project period).

4.1.2.1 The choice of a social discount rate

When considering an appropriate social discount rate, note must be taken of the various points of departure in the economic literature[18], as well as of the rates applied in other countries and by international development institutions.

The points of departure in the literature can be divided broadly into three schools of thought, namely those who argue that the discount rate should be equal to the marginal return on capital (opportunity costs of capital), those whose argument rests on long-term real interest rates (cost of funding to the State), and those who advocate a social time preference rate.

[18] **For an up-to-date presentation of the theoretical foundations of social discount rates, as well as alternative social discount rates methods in the absence of perfect markets, see Boardman, Greenberg, et al, Ibid Chapter 5.**

The first two schools take an economic view while the third school adopts a multiple-goal approach which includes social aims. In the debate in the literature, arguments and criticism are based on purely economic grounds, as well as on the basis of what exactly the "public interest" involves. A lack of space makes detailed discussion of the arguments impossible, and the reader who wants more background on this interesting (and sometimes deeply philosophical) debate is referred to the book by Sugden and Williams (1983) [19] .

There is no consensus concerning what method should be used to determine the social discount rate. A relative pragmatic approach is proposed which takes the following into account:

(i) The discount rate should not be influenced by business cycle conditions and policy, since the preferences that find expression in this rate are aimed at the extension of the long-term welfare structure.

(ii) A low discount rate generally favours projects with a high initial capital cost and low future current costs, while the opposite applies to high discount rates. Since labour costs are part of current expenditure, a high discount rate favours the employment of labour in future.

(iii) If the real social discount rate is lower than the real implicit discount rate in the private sector, then investment by the public sector will be encouraged at the expense of investment by the private sector. The larger the gap between the two, the stronger the effect.

4.2 Project Assessment Criteria

There are several project assessment criteria, which can be classified broadly as limited methods or more comprehensive methods.

4.2.1 Limited methods

These criteria include the payback period method, the peak profit method and the average profit method. All three are very simple and are restrictive because efficiency is not the main consideration. As a result, these limited methods may produce misleading results. The use of these methods is not recommended, and therefore they are not discussed here in detail.

4.2.2 More comprehensive methods

4.2.2.1 Net present value method

According to this method the difference between the benefits and costs (the net benefit) in the specified year is discounted to the present by using the social discount rate. The discounted sum of all these net benefits over the economic

[19] **Sugden R and William A. 1978.** ***Principles of Practical Cost-Benefit Analysis*****. Oxfort University Press.**

project life is defined as the net present value (NPV). In terms of the terminology set out above.

$$NPV = \Sigma bj/(1 + 1)j - \Sigma cj/(1 + i)j.$$

The criterion for the acceptance of a project is that the NPV must be positive; in other words, funds will be voted for a project only if the analysis produces a positive net present value. Where a choice has to be made between mutually exclusive projects, the project with the highest net present value will be chosen since it maximises the net benefit to the community.

4.2.2.2 The internal rate of return

The internal rate of return (IRR) is the discount rate at which the present values of cost and benefits are equal. It is therefore the value of the discount rate r which satisfies the following equation:

$$\Sigma bj/(1 + r)j - \Sigma cj/(1 + r)j = 0.$$

Only projects with an IRR higher than the social discount rate, which forms a lower limit, will be considered for funding. The IRR must be handled carefully, because there are situations in which the mathematical solution of the above equation is not unique. This happens when the stream of net benefits over the assessment period changes its sign (positive or negative) more than once.

4.2.2.3 The discounted benefit-cost ratio

The discounted benefit-cost ratio (BCR) is the ratio of the present value of the benefits relative to the present value of the costs, i.e.

$$BCR = \{\Sigma bj/(i + 1)j\} / \{\Sigma cj/(1 + i)j\}$$

A project is potentially worthwhile if the BCR is greater than 1. This means that the PV of benefits exceeds the PV of costs. Under this decision rule, if alternatives are mutually exclusive, the alternative with the highest BCR would be chosen.

It is recommended that the BCR is not adopted as the prime decision rule. BCRs can sometimes confuse the choice process when the policies under consideration are of a different scale, yielding misleading results. For example, if proposal A has a PV of benefits of 200 and PV of costs of 100, it has a NPV of 100 and a BCR of 2. If the alternative proposal, B, has a PV of benefits of 600 and costs of 400, it has a smaller BCR (1.5) but a larger NPV (200). It would be more efficient to choose proposal B.

The NPV, IRR and BCR criteria are not the only discounting measures used in CBA. There are also the net discounted end value, the net benefit-investment ratio and the yearly value method. The first-mentioned three are, however, theoretically well founded and are the ones most commonly used in practice. These three criteria should be applied in respect of every project analysed.

An example will illustrate the use of the NPV and BCR methods. The Table 3 contains the present values of the benefits and costs involved in the construction of a dam.

Table 3: The Present Value of Benefits and Costs of the Construction of a Dam (Rand)

Benefit/Cost	Present benefit	Present cost
Construction of dam		2 501 000
Annual Maintenance		259 000
Household Water Benefits	2 851 000	
Irrigation Water Benefits	473 000	
Recreation	716 000	
TOTAL	R4 040 000	R2 760 000

In the previous example the NPV = R4,04 million – R2,76 million = R1,28 million and the BCR = (R4 040 000 – 259 000)/2 501 000 = 1,51.

In terms of both measures the project can therefore lay claim to funding. The internal rate of return method would have arrived at the same results.

A further example will illustrate the use and limitations of the NPV and BCR measures in comparing a number of mutually exclusive projects. The road analysed above now competes with two mutually exclusive projects for funds. The details are contained in Table 4.

Table 4: Present Values of Costs and Benefits: Three Mutually Exclusive Projects (different dam sites)

(Rand)				
Dam Sites	Present value of benefits	Present value of capital costs	Net present benefits	BCR
1	3 781 000	2 501 000	1 280 000	1,51
2	5 000 000	3 500 000	1 500 000	1,43
3	3 350 000	2 200 000	1 150 000	1,52

Looking only at the BCR, it appears that dam site number 3 is the best choice, since it will provide R1,52's worth of benefits for every rand spent. However, it can be seen that this reasoning is incorrect if site 1 is compared with site 3. By spending a further R301 000 on site 1, a benefit of R431 000 more than that of site 3 is achieved. This means that site 1 provides a Pareto improvement relative to site 3. Those who benefit from site 1 can compensate all losers and still leave a surplus of R130 000. Using a similar argument it can be shown that site 2 is an improvement on site 1 and is therefore the best of the three alternatives. Generally, it can be argued that, in the case of mutually exclusive projects, the project with the highest NPV has the highest potential Pareto improvement.

4.3 General Sensitivity Analysis

4.3.1 Background

In most cases, a CBA is performed for new future projects and thus entails the estimation of certain key variables such as expected price and quantity. Although it could be accepted that the decision-maker is fully aware of the fact that the projected outcome of a project cannot be interpreted in absolute terms, it is important that the analyst provides the decision-maker with some idea of the degree of certainty/uncertainty to which the project outcome would be subjected to.

4.3.1.1 Selective sensitivity analysis

Project-evaluators usually perform a so-called Selective Sensitivity Analysis in order to establish the sensitivity of a project's outcome to changes in a limited number of key input variables. In essence, the analyst selects a key variable/parameter, one which he feels is both subject to wide variations and capable of significantly affecting the results of the CBA. The analyst then selects likely high and low (best and worst) outcomes for this parameter and repeats the computation of the CBA using these values. The decision maker is thereby presented with several possible results for each project – high, a medium and a low outcome for each of the parameters selected for the sensitivity analysis.

The major drawback of this limited approach is that it is not very suitable for the analysis of anything more than a few parameters. It not only causes problems when attempting to present the results in a scientific manner, but it also omits a great deal of information important to the decision-maker. Normally, the impact on the viability of a project through the change in any single parameter is compared to the base scenario. The ideal, however, is to calculate all the combinations of worst, standard and best for each parameter selected for the sensitivity analysis. Although this is technically possible, the presentation of such an analysis could be a major problem. To illustrate, when doing a sensitivity analysis with 10 parameters, each with a worst, medium and best value, the model calculated 310 or 59 049 possible outcomes for the project.

4.3.2 General sensitivity analysis

In using General Sensitivity Analysis, the problems encountered in Selective Sensitivity Analysis, namely the limitations with regard to the number of input parameters are overcome to a large degree. A General Sensitivity Analysis hinges on the derivation of a probability distribution of possible outcomes. Hereby, all the information contained in the above-mentioned 59 049 individual possible outcomes is captured in a format which is very convenient to the decision-maker for interpretative purposes. Without describing the methodology of the General Sensitivity Analysis in detail, it can be mentioned that it involves the following:

a) The calculation of results using all possible combinations of input parameters;
b) The probability of occurrence of each combination; and
c) The construction of a cumulative probability distribution function.

The following information can be obtained from the analysis:

a) The probability of the project being viable;
b) The probability that the project will not be viable;
c) The probability that the project will yield a particular return; and
d) The expected return (or best single estimate).

4.3.3 Computer model

The General Sensitivity Analysis is done by making use of a computer programme called @RISK (advanced risk analysis for spreadsheets) by the Palisade Corporation, USA, and September 1996.

@RISK uses simulation, sometimes called Monte Carlo simulation, to do a Risk Analysis. Simulation in this sense refers to a method whereby the distribution of possible outcomes generated by letting a computer re-calculate the CBA worksheet over and over again, each time using different randomly selected sets of values for the probability distributions of each key input variable. In effect, the computer is trying all valid combinations of the values of input variables to simulate all possible outcomes. This is similar to running hundreds or thousands of "what-if" analyses on the worksheet, simultaneously.

4.4 Income Distribution (Welfare Distribution between Contemporaries)

As mentioned in Paragraph 1.4.4, CBA is geared to the improved allocation of scarce resources. The guideline is the achievement of Pareto optimality. This means that resources are used in such a way that at least one person will be better off while in the process no-one will be worse off. If the discounted benefits of a proposed project exceed the discounted costs, the possibility exists of bringing about a Pareto improvement, provided that the winners compensate all the losers for their losses while at the same time retaining their surpluses. In practice this does not necessarily happen and the practical effects of the project on income distribution have to be determined.

All the project assessment criteria discussed so far, have been exclusively concerned with the achievement of a potential Pareto improvement and have not touched on the equitable distribution of consumption between contemporaries. Since this is one of the important objectives of economic policy, the government should quantify the most important distribution aims by allocating weights to specific groups. The fundamental point of departure is that additional incomes for lower income groups should be relatively more important than additional incomes for higher income groups. It is important to analyse the project in order to determine who the winners and losers will be. The following effects are of importance:

- who pays more and who pays less as a result of the project;
- who receives more and who receives less as a result of the project; and
- who benefits and who loses in other ways as a result of the project.

The following serve as broad guidelines concerning the role-players that could be involved in such as evaluation:

- the contractor of the project;
- other businesses that provide project inputs;
- government, which may profit from charging tariffs or may have to support the project financially in one way or another;
- the workers, or different categories of workers;
- the end-users of the product or service; and
- foreign countries, which may be affected through imports and exports.

The role-players who are referred to can also be seen in the context of a local, regional or national perspective. Accordingly use can be made of regional or local weights to achieve specific development objectives for an area.

The weights to be allocated to the different groups are not easily determined and depend largely on political decisions. It should, however, be related to the marginal utility that additional income provides for each of the groups. In order to make effective decisions, it is important for the decision-maker in the government sector to know what weights the politicians attach to particular groups or regions at a particular point in time, so that, after the completion of the financial and economic analysis, the income distribution potential of each project can be pointed out in detail. In South Africa such weights are not explicitly available. Nevertheless, recent development in the compilation of more contemporary SAMs, have made it possible to include such weights for household income groups for CBA-purposes. The theory and practice are set out in the following section.

4.4.1 Income weighting systems

4.4.1.1 Theory

From the above discussion, it is obvious that the concept and practice of weighting of different income groups should be viewed with a great deal of circumspection. Especially in the South African context where large differences between high and low income groups do occur.

For the purposes of this manual it is proposed that the first round of calculating the distributed impact (with the help of a SAM-based model) is done without a weighting system. After obtaining the initial results, use can be made of appropriate ratios to demonstrate the relative impact on the lower income groups.

For example what percentage of the total impact (direct and indirect) on personal income is earmarked for the lower, medium and higher income groups. In the absence of elasticity data, as a first round of weighting, use can be made of deviations from the mean / average national income per capita of each income group.

As stated previously, in principle, distributional objectives can be incorporated in project selection by assigning weights to income changes to different groups. This weighting of income flows to different groups allows revised NPV and IRR measures to be calculated and hence allows a distributional objective concern to be built into conventional decision-taking criteria.

In response to the perceived importance of distributional issues there is a well-developed methodology for income weighting[20].

The best known form of weighting involves a simple formula that assumes that the social value placed on a unit of income declines at a constant rate for all income levels. Application of this approach requires two parameters. The first is a reference level of income that will have a weight of unity. The main candidate for this reference level is average per capita income in the economy, but alternatives include a poverty line estimate or the income at which individuals become eligible for government subsidies. The second parameter is technically the elasticity of the social utility function for income. It reflects the rate at which the income weight for an individual or group declines as per capita income rises and in principle captures the strength of society's preference for income equality. By assumption this rate of decline or elasticity is constant for all income levels.

The income weight formula is thus:

$$di = (Ya/Yi)n \qquad (1)$$

where

di is the weight for group or individual i
Yi is per capita income for i
Ya is the reference income, which we assume is the national average per capita income,
n is the elasticity parameter

Using (1) income weights will decline the higher Yi is relative to Ya – that is, the better-off i is relative to the national average, and the higher n is, the stronger is society's commitment to equality. Use of this formula can be illustrated using values of n of 0.5 and unity (Table 5).

[20] **For more detail please consult:**
Guide to Practical Project Appraisal, Social Benefit – Cost Analysis in Developing countries, Under Vienna; 1986 in Chapter VII.
Project Analysis in Developing Countries – Second Edition – Steve Curry and John Weiss, Maccullian Press Ltd. – Second Edition, 2000, Chapter II.

Table 5: Illustration of Income Weights

Income (Ya = 100)	n = 0.5 weights	n = 1.0
Yi = 50	1.41	2.00
Yi = 80	1.12	1.25
Yi = 200	0.71	0.50
Yi = 300	0.58	0.33

Table 6: Re-valuation of Telecommunications Project with Income Weights

Stakeholders	NPV	Average income	Income n = 1.0, Ya = 100	Weighted NPV
(Pesos million)				
Project owners	0.46	500	0.20	0.09
Lenders	-2.20	500	0.20	-0.35
Government	-2.04	100	1.00	-2.04
Project workers	0.91	80	1.25	1.14
Telephone users	6.15	70	1.43	8.79
TOTAL	3.28			7.63

Source: S. Curry and J. Weiss – pp 290-291.

Using such income weights to revalue the telecommunications project presented in Curry and Weiss[21] would require a choice of n and an estimate of the average income of the different groups affected by the project. Table 6 illustrates the approach using the income figures at domestic prices. They assume that 20 percent of telephone users are poor with a per capita income of Pesos 50 whilst the remaining 80 percent have a per capita income of 75, which is 75 percent of the national average. The weighted average income of users is therefore Pesos 70. They then use the national average income as the reference level for weighting. It is assumed that project owners have an income five times the national average and that lenders are a private sector institution whose losses represent a reduction in profits for shareholders again with an income level five times the national average. Reductions in government income are assumed ultimately to affect those on average incomes through higher taxes. Finally project workers are assumed to have an income 80 percent of the national average. In calculating the weights a value of n = 1.0 is used.

With the use of income weights the project's NPV has increased substantially to Pesos 7.63 million. This is primarily because its main beneficiaries, the users, have below average incomes and some have very low incomes and are classed as poor. On the other hand, one of the losing groups, the lenders, have high incomes and their losses have little social value. When weights are applied consistently projects can be ranked by their economic NPVs and in this case the project should look better relative to alternatives because of its egalitarian distributional effect.

[21] **"Project Analysis Ibid on cit. p 290.**

Although this methodology of weighting is well known, it is rarely applied in practice. This is in part owing to what are seen as the complications regarding its additional data requirements. More importantly, perhaps, is the point that the use of a particular set of weights is essentially subjective since their value will vary with the assumed elasticity parameter n. In the absence of any agreement on this parameter there is the possibility of inconsistency in decision-taking with comparisons between projects where different weighting regimes have been applied. In addition weights such as those in Table 1 have been criticized since they can imply the justification of a high level of economic inefficiency in pursuit of distributional goals.

For example, with n = 1.0 a project with benefits of 25 and costs of 100 (that is, with a net loss of 75) would be justified if the benefits went solely to those with an income of half the national average (and thus a weight of 2.0), whilst it's costs were borne solely by those with an income twice the national average (and thus a weight of 0.5). The point here is that whilst raising the income of the project beneficiaries by 25 may be justified in terms of social priorities, doing it at a net cost of 75 is likely to be a very inefficient means of reaching this target group. The expectation would be that there would be less costly means of affecting the transfer (for example, through subsidy schemes or targeted work programmes) than implementing a loss-making project.

4.4.1.2 Practice

As discussed above the income weight system is still being debated. Although the theoretical principle is probably sound, the practical application is still problematic. In view of this it is recommended that the principle of the income weight system should be introduced gradually. In this regard it is proposed that the elasticity of the social utility function for income could be set as a guideline at 0.20. This factor is in line with the priority that the government has given to income distribution indirectly via the percentage allocation in respect of government tenders to previously disadvantaged individuals.

In view of the fact that the income weighting system is subject to criticism, a rather conservative elasticity of 0.20 is therefore suggested. It is important that the relevant CBA results should be presented to the decision-maker before and after the weights are applied. Furthermore it is also important that sensitivity analysis is applied by means of different elasticity parameters.

With regard to the reference level of income it is proposed that the average per capita income in the South African economy is used. The relevant figures can be obtained from the SARB Quarterly Bulletin. Table 6.1 also reflects provincial per capita income levels for unskilled workers. However, it is important to note that the decision maker should always be supplied with the results of the CBA analyses before and after the income weights are applied.

4.5 Welfare Consequences

The real locative effect of a project is only one of the effects that can be classified as of welfare consequence. In general, welfare effects include all the consequences that a project has for a human being's social milieu. These effects are related to changing living standards, new opportunities for development and self-improvement and the protection of the environment, but also with population movements and all the negative consequences attached to them, etc. Welfare effects are hard to quantify, but it is important that the analyst should point out any such effect in detail and systematically to the decision-maker, even if it is by qualitative means, to enable him/her to attach a subjective weight to it in order to arrive at a more considered decision.

4.6 Political and Constitutional Consequences

The project evaluator always operates within a certain constitutional environment which influences the shadow prices and the choice of distributive weights. Analysts will, however, endeavour to point out all the consequences of a project as objectively as possible. When decision makers act contrary to the recommendations of the analyst it must be very clear what price the community is paying for such politically inspired action.

It is not always possible to include all the political consequences in the CBA on a quantified basis, although it is the responsibility of the analyst to point them out in detail on a qualitative basis.

4.7 Strategic Consequences

Projects may be classified as strategic on grounds of the following philosophies:

- The self-preservation philosophy, which emphasises the survival of the community; or
- The egoistic philosophy, which wishes to deny other parties access to the markets but is often disguised as per the above.

Strategic projects are aligned to both national objectives and sectional objectives that are presented as national objectives. The objectives can be of various kinds – self-sufficiency in abnormal times, national prestige, the development of new technology, etc. The calculation of the strategic value of projects should be done on the basis of the probability that the circumstances being guarded against, will materialise and the degree to which the country is already dependent on the party against whom the project gives protection. This type of analysis should form part of the sensitivity analysis of the project.

Since strategic consequences are also difficult to quantify, care should be taken to guard against the misuse of the strategic argument in cost-benefit analyses.

In the last three sections it has been argued that the analyst must point out non-quantifiable consequences in detail and systematically to the decision-maker in order to enable him/her to allocate a subjective weight to them and so to make an optimal decision. Where an analyst or decision-maker expresses an opinion or decides between alternative projects, it is expected of the analyst or decision-maker unambiguously to indicate the considerations that have led to the decision.

CHAPTER 5: COMPOSITION OF A CAPITAL EXPENDITURE PROGRAMME

This chapter deals with methods of putting together a capital expenditure programme subject to a fixed budget when (i) only independent projects are presented for consideration and (ii) both independent and mutually exclusive projects are considered. The examples are derived from the book by M.S. Thompson (1980) [22] .

5.1 Independent Projects

When a choice has to be made between a number of independent projects, given a fixed budget, the BCR measure is the preferred criterion. An example will illustrate this point. Suppose a local authority with a limited budget of R5 million has to make a choice between twenty-six independent projects, five of which are summed up in Table 7.

Table 7: Present Value of Benefits and Costs for a Number of Independent Projects (Rand)

Project	Present benefit	Present capital cost	Net present benefit	BCR
A	420 000	300 000	120 000	1,4
B	1 350 000	1 000 000	350 000	1,35
C	350 000	200 000	150 000	1,75
D	900 000	600 000	300 000	1,5
•	•	•	•	•
•	•	•	•	•
Z	640 000	400 000	240 000	1,6

Here the BCR criterion is the preferred measure to use. The project with the highest BCR value is selected first, followed by the one with second highest BCR value, and so on until the budget is exhausted. Thus, the five projects in Table 7 will be chosen in the order C, Z, D, A and B. In this way the benefit per rand spent is maximised.

5.2 Independent and Mutually Exclusive Projects

Suppose the objective of the decision-maker is to maximise community benefits subject to the restriction of a fixed budget and that both mutually exclusive and independent projects are under consideration. A method of project assessment based on the incremental principle is recommended. The method consists of seven steps, and although it is complicated, it can easily be carried out with the aid of a computer. The steps are as follows:

(i) Determine the size of the budget. Where some degree of freedom exists as to the total amount available, the amount can be expanded incrementally, and the

[22] **Thompson MS. 1980. Benefit Cost Analysis for Program Evaluating. London.**

marginal benefits compared with the marginal expenditure to determine whether any expansion of the budget is justified.

(ii) Eliminate all projects that exceed the budget limits and all projects which do not satisfy the minimum acceptance criteria as set out above.

(iii) Determine which project has the highest BCR within each group of mutually exclusive alternatives and then leave out the rest of the possible projects in the group.

(iv) From the projects under consideration choose the one with the highest BCR.

(v) Review the choice of the best project in each group of mutually exclusive projects by reconsidering all the more expensive projects and noting the marginal BCR. Within each group of mutually exclusive projects by firstly reconsidering all more expensive projects and noting the BCR. Within each group of mutually exclusive projects the project with the highest marginal BCR is identified and compared with the rest of the independent projects. Secondly, the available budget is adjusted to reflect the effect of the projects already chosen, and all remaining projects that exceed the balance of the budget are left out.

(vi) Repeat steps (iv) and (v) for as long as possible. The iteration process ends when the budget is exhausted or when no acceptable projects remain for consideration.

(vii) Consider adjustments to chosen projects when the budget is not completely exhausted and a small adjustment in a chosen project may provide marginal net benefits.

An example will clarify this procedure. Suppose a government has R1 million to spend. The projects under consideration are summed up in Table 8. Projects A1, A2, A3 and A4 are four mutually exclusive projects.

Table 8: Present Value of Costs, Benefits and Benefit-Cost Ratios of a Number of Projects

Project	Present capital cost (R'000)	Present benefit (R'000)	BCR
A_1	135	280	2,07
A_2	170	370	2,18
A_3	210	440	2,10
A_4	270	530	1,96
B	150	250	1,67
C_1	250	315	1,26
C_2	280	405	1,45
C_3	600	890	1,48
D_1	110	175	1,59
D_2	150	235	1,57
E_1	100	220	2,20
E_2	200	480	2,40
E_3	300	670	2,23
E_4	400	830	2,08
E_5	500	1030	2,06
E_6	600	1170	1,95
F	60	140	2,33

There is no project that exceeds the budget limit of R1 million and, furthermore, there is no project with a BCR of less than one. All projects are therefore included in further analysis. In Step (iii) the best projects are chosen from groups A, C, D, and E, and the projects that enjoy attention in the next step are reduced to the following:

Project	Present capital cost	Present benefit	BCR
A_2	170	370	2,18
B	150	250	1,67
C_3	600	890	1,48
D_1	110	175	1,59
E_2	200	480	2,40
F	60	140	2,33

E2 is chosen from these six projects. Now the more expensive projects in the E group are considered in terms of the marginal BCR. The marginal BCRs of the four projects more expensive than E2 are as follows:

Project	Marginal capital cost	Marginal benefit	Marginal BCR
$E_3.E_2$	100	190	1,90
$E_4.E_2$	200	350	1,75
$E_5.E_2$	300	550	1,83
$E_6.E_2$	400	690	1,72

The greatest marginal benefit is achieved by replacing E2 with E3; this replacement within the E group must now be considered together with the other projects. There is now R800 000 left and none of the project exceeds this limit. The six alternatives now under consideration are as follows:

Project	Present capital cost	Present benefit	BCR
A_2	170	370	2,18
B	150	250	1,67
C_3	600	890	1,48
D1	110	175	1,59
$E_3.E_2$	100	190	1,90
F	60	140	2,33

Project F is therefore chosen and R740 000 of the budget is left. The next project to include is A2, which immediately places the more expensive project in group A under the spotlight. The relevant marginal ratios are as follows: A3.A2 = 1,75 and A4.A2 = 1,6. The former is now compared with the remaining projects. There is R570 000 left to spend, and this eliminates projects C3, which is more expensive. C2 takes the place of C3 on the basis of the BCR criteria. The list under consideration is now as follows:

Project	Present capital cost	Present benefit	BCR
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_2	280	405	1,45
D_1	110	175	1,59
$E_3.E_2$	100	190	1,90

E3.E2 has the best ratio and E3, replaces E2 as chosen project. This costs an additional R100 000, leaving R470 000 for spending. The marginal BCR measures within the E group are as follows: E4.E3 = 1,60, E5.E3 = 1,80 and E6.E3 = 1,67. The list of competing projects is now as follows:

Project	Present capital cost	Present benefit	BCR
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_2	280	405	1,45
D_1	110	175	1,59
$E_5.E_3$	100	360	1,80

Project E5.E3 has the largest BCR, which means that E3 is replaced at a cost of R200 000. This leaves only R270 000 and means that C1 now replaces C2 on the list of competing projects.

Project	Present capital cost	Present benefit	BCR
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_1	250	315	1,26
D_1	110	175	1,59
$E_6.E_5$	100	140	1,40

Project A3 is chosen to replace project A2 which leaves R230 000 and eliminates C1. The following projects remain for consideration:

Project	Present capital cost	Present benefit	BCR
$A_4.A_3$	60	90	1,50
B	150	250	1,67
D_1	110	175	1,59
$E_6.E_5$	100	140	1,40

Project B is now chosen, leaving R80 000. Since only A4.A3 falls within this limit, A4 replaces A3, leaving another R20 000 in the budget. Therefore it is decided to fund A4, B, E5 and F at a total cost of R980 000. Benefits to the value of R1 950 000 are gained in the process.

In the last step small adjustments are made to increase the total benefits. The most attractive project eliminated on the grounds of the budget limit was D1. Sufficient funds can be acquired to pay for D1 if A2 is funded instead of A4. This leaves R15 000 of additional benefits at R10 000 of additional cost, and the final list of projects is therefore:

A2, B, D1, E5 and F.

Underlying this complicated procedure is the very simple notion that the decision-maker should endeavour to achieve the greatest possible benefit for every rand that (s)he spends. A small computer programme will greatly simplify this technique.

CHAPTER 6: PROCEDURE FOR THE APPLICATION OF COST-BENEFIT ANALYSIS

6.1 Introduction

In this chapter the procedure proposed for the practical application of CBA is set out. The procedure is of a general nature and is therefore appropriate for a wide range of public sector projects.

Although the procedure implies a number of steps taken in a specific order, the proposed order must not be viewed as absolutely rigid. It may be necessary for the analyst to return to previous steps once (s)he has acquired greater insight into the problem.

Furthermore, it is important that there should be constant interaction between the principal and the analyst. This interaction implies, among other things that the analyst can make suggestions to the principal with regard to the amendment of the alternatives and/or the identification of new alternatives.

Such interaction is only meaningful if the principal is acquainted with the theoretical points of departure of CBA, the scope and limitations of the technique and possible problems with regard to the availability of data. The principal must realise that CBA is part of the decision-making process in order to promote rational decision-making.

6.2 Application Procedures

In simplified terms a CBA entails:

- Identification of the impact of a project in terms of the costs and benefits resulting from it.

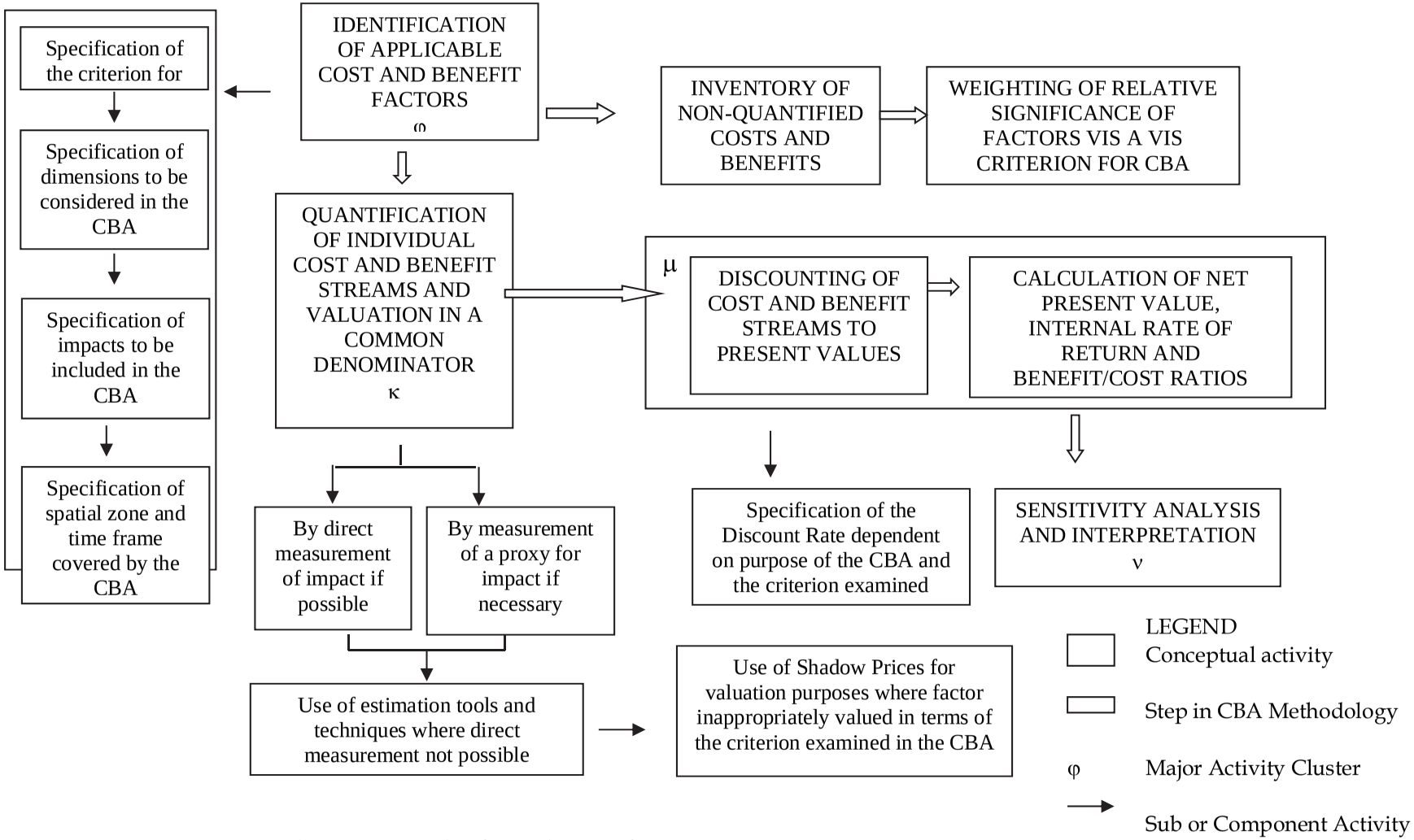
- Quantification by measurement or estimation of the streams of costs and benefits, which are generated by a project. Measurement and estimation techniques vary according to the nature of the costs and benefits. Cost and benefit streams are expressed, i.e. valued, in a common, usually monetary denominator. Shadow prices are used in valuation of some cost or benefit streams when market prices are either unavailable or inappropriate because they are distorted due to market imperfections. Discounting of the streams of costs and benefits to present values to allow comparison of the value of costs and benefits, which are incurred, or which accrue over different periods of time. A standardised rate is selected as discount rate for the calculation of present values of all cost and benefit streams.

- Determine the present value of costs and benefits and calculation of the internal rate of return of the project (the IRR) and the ratio of benefits to costs (the BCR).

- Sensitivity analysis of impact of variation of cost and benefit streams on project IRR and BCR. (The IRR in the economic application of CBA is known as the economic rate of return, ERR).

In Figure 1, a conceptual framework is set out for the development of cost benefit analysis. The framework charts the process and steps of CBA and indicate the activities required.

Figure 1: Conceptual Framework for Development of Cost Benefit Analysis Practice



Source: © Development Bank of Southern Africa, 2000.

Some of these activities are of a conceptual nature, being required to define the scope and focus of the analysis (such as specification of the purpose of the analysis, the criterion to be examined, dimensions to be considered, and impacts to be included). Other conceptual activities are required to give effect to the intent of the analysis (such as use of shadow prices where necessary and the defining of a discount rate with which to calculate the present values of cost and benefit streams).

With the aid of the above framework the generic nature and process of CBA is described below.

6.2.1 Steps in execution of Cost-Benefit Analysis[23]

The practical steps required to execute CBA are summarised in Table 9:

Table 9: Practical Steps in Execution of CBA

Step	Activity
1	Specification of purpose of the CBA and specification of project boundaries within which the analysis is to be conducted. By the setting of a perspective it is important that the analyst will acquaint her/himself with all the relevant facts in order to develop a feeling for the problem, the proposed solutions and the milieu within which a recommendation is to be made.
2	Identification of all impacts i.e. costs and benefits generated by a project within the boundaries specified for analysis. It must once again be emphasised that the analyst should measure the costs and benefits relative to the nil alternative. Further, it is important that the analysis should not be done in terms of only a single set of parameters, but that a whole number of critical scenarios should be investigated with the aid of sensitivity analysis.
3	Quantification of cost and benefit streams via direct measurement of the impact itself or, if necessary, measurement of an appropriate proxy for the impact. If direct measurement of the impact or proxy is not possible, the impact or proxy should be estimated using appropriate estimation tools and techniques.
4	Impacts, which are difficult to measure, should nevertheless be recorded in qualitative terms and if possible ranked in order of importance. The analyst should also, as far as possible, quantify the social consequences of a project, and where such quantification is not possible they should be reported qualitatively. The following social consequences of a project should be addressed: Distributional effects between income groups, population groups or geographical regions; Welfare consequences; Political and constitutional implications; Strategic consequences; Prestige; The creation of job opportunities; The achievement of economic independence; and Population movements.
5	Discounting of project cost and benefit streams to present values
6	Calculation of NPV, ERR and BCR to define the value of the project in economic terms.
7	Sensitivity analysis on the cost and benefit streams. The analysis should be based on risk factors, which have been identified in the project setting.
8	Interpretation and reporting of the results of the analysis.

[23] **Procedures used by DBSA.**

6.3 Report Writing

It is necessary that the research should be well documented for future references. However, it is important to convey to the decision maker the results of the CBA in such a manner that (s)he understands the project and is able to take a decision without studying detailed unnecessary information.

The last task of the analyst involves the completion of a summary that gives the decision-maker an overview of the most important aspects of the analysis.

The summary should preferably not be longer than five pages and should cover the following aspects (it is important to note that the following should be seen as a guideline that can be deviated from by way of exception where valid reasons exist):

Purpose of CBA

This section contains a short specification of the purpose of the CBA, formulated as a problem statement. The boundaries (project boundaries) within which the analysis was conducted are also specified. In more detail it entails the following:

(i) An introductory paragraph that covers the following aspects:

- The long-term expenditure programme and the expenditure vote/programme within which the project must/can be accommodated;
- The fact that the summary is intended to set out the most important financial, economic and social implications of the project.

(ii) The project identification, which includes the following:

- The determination of a need; an explanation of the present situation, the nature of the problem that gave rise to the need for a solution, and the solution that is presented;
- The technical solutions; an explanation of the alternatives identified by the principal and evaluated in the analysis.

(iii) The aim of the analysis:

- An explanation of the fact that the aim of the analysis is to identify the financial, economic and social implications of the alternatives in order to identify the best alternative.
- An explanation of the costs and benefits included and excluded from the analysis.

(iv) The limitations:

- An explanation of any considerations that may lead to the elimination of any of the alternatives, for example strategic or political implications, or legal restrictions.

Key assumptions

This section contains a specification of the key assumptions and proxies used in the calculation of the CBA.

Results of CBA

- In this section the results of the cost-benefit analysis calculations of NPV, ERR and BCR are reported. They are then interpreted against project selection criteria.
- Aspects that should be reported on include:
- tariffs
- government and other subsidies
- funding options.

Inventory of non-quantified costs and benefits

In this section an inventory of non-quantified costs and benefits is made and their relative significance to project economic impact, indicated. It should indicate the social, welfare, political, constitutional and strategic consequences.

Sensitivity Analysis

A description of the sensitivity and critical considerations, which include:

- The identification of that parameter (assumption or prediction) that has been pointed out as the most critical;
- provision of the most likely spectrum of values of this parameter;
- Identification of the cut-off point within this spectrum of values;
- Explanation that the success of the project may depend on the completion and/or success of another project or projects.

Reasoned recommendation

In this section the rationale for recommending or declining support for a project on the basis of impact on society welfare is summarised.

CHAPTER 7: DETERMINING SHADOW AND SURROGATE PRICES FOR SOUTH AFRICA

7.1 Introduction

In practice, determining shadow and surrogate/associated prices for use in a CBA is normally a task that requires the application of underlying economic principles to specific circumstances. This requires a basic knowledge of the relevant economic principles, and the specific inputs and outputs being analysed. However, it is important to bear in mind that, in the light of the various prices, and the variation in prices used in a CBA, it is not possible to calculate shadow and surrogate prices for every input and output.

Nevertheless, general practical guidelines and broad estimates can be provided for prices of certain inputs and outputs. This is done on the understanding that certain cases may require a more detailed approach. Where the results of a CBA can be largely dependent on the method of shadow price calculation, the effect of alternative shadow prices on the results of a project should be subjected to a sensitivity analysis.

7.2 Theory of the Real Social Discount Rate

Over-arching Approach to Determine the Discount Rate:

The United States Environment Protection Agency (EPA), cited by Luus and Mullins (2007)[24], distinguishes between two major discounting approaches: intra-generational discounting and inter-generational discounting, depending on the expected impact of an investment decision over time.

7.2.1 Intra-generational discounting

The intra-generational discounting approach is best suited for analysing costs and benefits that derive from an investment over a relatively short period of time - up to decades-long time frames. This approach does not explicitly confront the extremely long time horizons and impacts of an investment decision on unborn generations. Generally, this approach applies an exponential[25] discounting method using a constant discount rate converting the future costs and benefits of a given investment into net present values.

7.2.2 Inter-generational discounting

On the other hand, the inter-generational discounting approach is appropriate for discounting future costs and benefits derived from an investment over extremely long term periods, the impact of which will spread over more than a generation or even hundreds of years. Generally, the inter-generational discounting approach is used for discounting long term impacts such as climate change. Unlike the intra-

[24] **Luus C.W. and Mullins D. 2008. The Discount Rate for Cost-Benefit Analysis by the DBSA. p 8.**
[25] **See Annexure 2 for more information concerning intra-generational discounting and exponential discounting.**

generational approach, more often, inter-generational approach makes use of a hyperbolic[26] discounting which applies a variable discount rate that does not effectively decline as steeply towards the end of the programming period.

7.3 Theoretical Substructure for the Calculation of the South African Discount Rate

7.3.1 Discount rate for Intra-generation

The real social discount rate proposed for South Africa is based on the principle of the social rate of time preference (SRTP) method, which is one of the methods of calculating a real discount rate for intra-generational projects. The SRTP is the rate at which households are willing to trade a unit of current consumption in exchange for more future consumption.

There are two models of estimating the SRTP. One is the approximation of the SRTP by the after tax rate of return of the government bonds or other low risk marketable securities. The other is the application of the Ramsey formula[27]. According to Ramsey's formula derived from an economic growth model, SRTP is the sum of two elements: the first is the utility discount rate reflecting the pure time preference of consumers and the second is the product of two sub-elements viz - the elasticity of the marginal utility of consumption and the annual rate of growth of per capita real consumption. The second element of the formula reflects the fact that, when per capita income grows over time, consumption is also expected to grow, and people will become less willing to save in the current period to obtain more in the future, because of the diminishing marginal utility of consumption.

There is a general consensus, worldwide among Economists that the SRTP approach should be used especially when discounting inter-generational projects[28]. Also the SRTP seems appropriate for South Africa because it proves to be much more stable and does not fluctuate with the business cycle such as other rates.

It should be noted that apart from the SRTP method, three other methods of calculating the discount rate for intra-generational projects can be put forward: (i) Social opportunity cost (SOC), (ii) Weighted average approach, and (iii) Shadow price of capital (SPC) approach.

[26] **See Annexure 2 for more information concerning inter-generational discounting and hyperbolic discounting.**
[27] **Zhuang J., Liang Z., Lin T., and De Guzman F. 2007. Ibid. p4.**
[28] **Zhuang J., Liang Z., Lin T., and De Guzman F. 2007. Ibid. p16.**

- Social Opportunity Cost (SOC)

The social rate of discount calculated by this method is based on the rate of return of the next best alternative use of funds. Generally, the next best alternative use of funds is thought to be the average return on investment in the private sector.

Luus and Mullins (2008)[29] cited three models for estimating the social opportunity cost which are: Capital asset pricing models (CAPM); Arbitrage pricing theory (APT), and Fama and French's multi-factor model.

- Weighted Average Approach

Since SRTP does not take into account the social opportunity cost of public investment and SOC does not take into account the impact of public investment on consumption spending, several economists have suggested that the social discount rate should be a weighted average of the SRTP and SOC[30].

- Shadow Price of Capital Approach

The shadow price of capital (SPC) approach attempts to reconcile the SRTP approach with that of SOC and, at the same time, addresses the limitation of the weighted average approach. In practice it is very difficult to ascertain what the SPC actually would be and requires sophisticated formulas and models.

7.3.2 Discount rate for inter-generational

Luus and Mullins (2007), distinguished between the social welfare planner approach and approaches based on existing individual's time preferences as methods of calculating a social discount rate for extremely long-term projects, which involve unborn generations. The two methods can be described as follow:

- Social welfare planner approach

One popular recommendation is that social discounting for inter-generational policies should be based upon optimal growth analyses. In optimal growth models, the social rate of discount generally equals the sum of two factors. One is a discount rate for pure time preference, which measures the degree to which the social planner favours the utility of current and near future members of society over that of individuals in the more distance future. The other is an adjustment reflecting the fact that the marginal utility of consumption will decline over time as consumption per capital increases (equal to the elasticity of marginal utility multiplied by the rate of increase of consumption over time).

[29] Luus, CW., and Mullins, D., 2008. Ibid. p. 19.
[30] Boardman, J. and Winning W. 1996. CBA – Concepts and Practice; Prentice-Hall Inc; p28-29.

- Approaches based on existing individuals' time and consumption preferences

The major alternative to the social welfare planner approach for inter-generational discounting is to rely on the preferences of current individuals that will indicate an appropriate discount rate. At its core, this perspective rejects the view that the problem is one of balancing the interests of all humans who will live now and in the future. Instead, according to this perspective, it is fundamentally about individuals alive today allocating their scarce resources to competing ends, one of which happens to be the welfare of future generations.

Both the above two methods mentioned make use of the hyperbolic discounting method when analysing costs and benefits that occur in the "far future".

With hyperbolic discounting the discount rate is not constant over the programming period, and can be presented algebraically as follow:

$$PV = \frac{FV}{(1+rt)} \qquad (1)$$

Where:
r = discount rate;
t = time
As indicated before, the exponential discounting method is mostly applied to projects straddling over intra-generational periods. The discount rate remains constant, and can be presented by the following equation:

$$PV = \frac{FV}{(1+r)^t} \qquad (2)$$

The following Table explain the differences in impact of an investment project with a discount rate of 8 percent over 100 years, using either the exponential or the hyperbolic discounting method.

Table 10: Difference between exponential and hyperbolic discounting (Rand)

Years	Observed value	Exponential discounting	Hyperbolic discounting
10	**100**	**46.32**	**55.56**
20	100	21.45	38.46
30	100	9.94	29.41
40	100	4.60	23.81
50	100	2.13	20.00
60	100	0.99	17.24
70	100	0.46	15.15
80	100	0.21	13.51
90	100	0.10	12.20
100	100	0.05	11.11
	Total Net Present Value	86.25	236.45

Source: Conningarth simulation.

Based on a discount rate of 8 percent, it can be seen from Table 10 that the present value of an investment, using exponential discounting, falls quickly during the latter part of the programming period. Opposed to this, the present value of an investment, using hyperbolic discounting, and takes much longer before it starts to taper off and when it does it is at a much slower rate than the exponential method.

This method makes it more suitable to deal with long-term inter-generational projects giving more weight to benefits/costs that might accrue at the latter parts of the programming periods. This way of discounting future benefits and costs makes it more suitable for analyzing the environmental impacts of projects.

It is important to note that the hyperbolic discount figure is much more nearer to the observation figures (future value) and it is advisable to make use of the hyperbolic discounting for analysing the environmental impact of an investment project.

7.4 Current International Development

This section provides a survey of the social discount rates used by different countries and financial institutions around the world. Table 11 below contains the recommended discount rate used by various countries around the world. As is to be expected the discount rates vary significantly among countries.

Table 11: Real Social Discount Rates in Selected Countries and Institutions

Country	Discount Rate (percent)	Theoretical Basis
Philippines	1991: 8% : SOC rate annually reviewed	SOC approach
Canada	10%	SOC approach
Peoples Republic of China	8% for short term and medium term projects: lower than 8% for long term projects	Weighted Average Approach
France	Real discount rate set since 1960:set at 8% in 1985 and 4% in 2005	1985 : To keep a balance between public and private sector investment
Germany	1999 : 4% 2004 : 3%	Based on federal refinancing rate, which was over the late 1990s was 6% nominal: average GDP deflator (2%) giving 4% real.
India	12%	SOC Approach
Italy	5%	SRTP Approach
New Zealand	10% as a standard rate whenever there is no other agreed sector discount rate	SOC Approach
Norway	1978 : 7% 1998: 3.5%	Government borrowing rate in real terms
Pakistan	12%	SOC approach
Philippines	15%	SOC approach
Spain	6% for transport : 4% for water	SRTP approach
United Kingdom	1967 : 8% 1969 : 10% 1978 : 5% 1989 : 6% 2003 : 3.5% Different rates lower than 3.5% for long term projects over 30 years	SOC approach until 1980s; thereafter SRTP approach
US (Office of Management and Budget)	Before 1992 : 10%;after 1992 : 7%	Mainly SOC approach
US (Congressional Budget Office and General Accounting Office)	Rate of marketable Treasury debt with maturity comparable to project span	SRTP approach
US (Environmental Protection Agency)	Intragenerational discounting: 2-3% subject to sensitivity analysis in the range of 2-3% and at 7%. Intergenerational discounting : range of 0.5-3% and at 7%.	SRTP approach

Source: Asian Development Bank (ADB). (Zhuang et al. May 2007)

Theoretically, differences among countries can in general be attributed to the differences in time preferences of societies. While developing countries are using higher discount rate, developed countries use lower discount rates. This can be

explained by various factors such as that developing countries' have a capital shortage compared to developed countries, and that the risk factor is larger with developing countries compared with that in developed countries. There are also other factors such as differing inflation rates, quality and quantity of labour resources etc.. It has been supported that lower discount rate is labour unfriendly, therefore it favour capital-intensive project and the opposite is true for higher discount rate. According to Zhuang et al (2007), Development Finance Institutions such as the World Bank, African Development Bank, Asia development Bank and the European Bank for Reconstruction and Development apply a real Social Discount Rate of between 10 and 12 percent.

7.5 Proposed Discount Rate

Taking into account the international discount rate benchmarks and the marginal return on capital approach, the current "official" 8 percent discount rate applicable in South Africa still seems to be reasonably applicable for both inter and intra-generational discounting.[31].

Currently there is a view by some economists that the current 8 percent discount rate applicable in South Africa might be too high. This is sometimes attributed to the fact that some developed countries have lowered their discount rates (see Table 11 France, Norway, Germany, New-Zealand and Canada during the last decade). The rationale why these countries have lowered their discounting rates is that their interest rates have come down appreciably in recent years.

The following arguments do not support the view of lowering the current 8% discount rate:

- In a recent survey conducted by the Asian Development Bank[32] on the Real Social Discount Rate, the following findings are worth highlighting: "The survey's authors define the real social discount rate as a reflection of a society's relative valuation on today's wellbeing versus wellbeing in the future. The appropriate selection of a social discount rate is crucial for cost benefit analysis, and has important implications for resource allocations. There is wide diversity in social rates, with developed nations typically applying a lower rate (3-7%) than developing nations (8-15%).

- Given the rather low domestic savings rate in South Africa and the higher savings rates in capital exporting countries, one can argue that the real discount rate in South Africa is still relatively low. Interest rates in advanced economies came down significantly in recent years as well as in South Africa where both the real interest rate and the SRTP are well below 8 percent. Nevertheless, a discount rate of 8 percent does not reflect South Africa's true shortage of investment capital and therefore the premium on using capital

[31] **Luus C.W. and Mullins D. 2008. The Discount Rate for Cost-Benefit Analysis by the DBSA. p 8.**
[32] **Symons, E-K Reviewing Social Discount Rates. Asian development Bank No. 2 June 2008.**

resources more productively. At present (2012 – 2013) gross domestic savings in South Africa is at a level of only 15.1 percent of GDP. The current growth rate (2012 – 2013) is about 3 percent. In order to generate a 6 percent sustainable economic growth which is needed to absorb unemployment in South Africa it will imply more pressure on using scare capital resources productively. One way to do this is to have a high discount rate that ensures that only the best projects are considered for funding. A relative high discount rate also favoured labour intensive projects.

- The issue of the discount rate was also discussed with the Industrial Development Corporation(IDC), the Development Bank of Southern Africa(DBSA), the South African National Roads Agency (SANRAL) and the National Treasury (NT). They were of the view that the real discount rate of 8% should not be lowered in view of the current state of the RSA economy. An important comment from the National Treasury was that most of South Africa's major investments will probably be financed through foreign investment. Due to the fact that the Rand exchange rate will depreciate over time relative to the currencies of its major trading partners, the cost of the loans is not only the interest rate that will be paid but also the additional Rands that must be paid due to the depreciation of the Rand to service and repay the loans in the end of its lifespan.

- By using different methods in estimating the real social discount rate for South Africa, Luus and Mullins (2008)[33] found that most of these estimates range between 8.4 and 9.6 percent in real terms.

- The South African Government Bond rate can also be used as an indication of an opportunity cost of using capital (Discount Rate). According to Bond Market data as published by the South African Reserve Bank Bulletin[34] from 2003 to 2013, the 10 Year South African Government Bond averaged 8.52%. This is a nominal rate. If converted to a real rate by taking into account inflation of 4.11% over the same period it realise a real rate of ± 4.4%. It is important to note that the Government Bond rate is regarded as a risk free rate. If a risk factor of between 3% to 4% is added to the risk free rate of 4.4% it translates to a equivalent discount in the order of 8%. A risk factor of between 3% to 4% could be viewed as conservative if the real return on equity in the private sector as calculated by Luus and Mullins (2008)[35] at 12% in nominal terms, ±6% in real terms. This 6% can also be viewed as a risk factor that the private sector take into account when they make investment decisions.

[33] For a detailed discussion on the empirical rates and assumptions used, see: Luus C.W. and Mullins D. (2008); The Discount Rate for Cost-Benefit Analysis by the DBSA
[34] South African Reserve Bank Bulletin. No 271. March 2014
[35] For a detailed discussion on the empirical rates and assumptions used, see: Luus C.W. and Mullins D. (2008); The Discount Rate for Cost-Benefit Analysis by the DBSA

Social opportunity cost rate method

As already indicated, the social opportunity cost rate method is the rate of return to balance the social opportunity cost of undertaking the project in the public sector versus the next best alternative in the private sector where rates are observable. The formula to calculate this rate is based mostly on the yield that a project in the private sector earns in real terms.

The weighted average cost of capital (WACC) formula forms the basis of the social opportunity cost rate method. The discount rate would be the weighted average cost of capital. The formula is:

$$WACC = (1 - Tc)\, kb\, D/(D + E) + ke\, E/(D + E)$$

Where:
- Tc = corporate tax rate
- Kb = return on debt
- ke = return on equity
- D = amount of bonds (debt)
- E = amount of equity (share capital)

In the study conducted by Luus and Mullins (2008)[36] this rate was calculated as 9.6% if no taxes are assumed (i.e. for public sector funded projects).

Social time preference rate method

Another school of thought argues that the correct rate of discount to be used for public projects is the social time preference rate (STPR) which is also called the subjective communal discount rate, or the consumption rate of interest (CRI). The rationale for this argument is quite simple: the purpose behind investment decisions is to increase future consumption, which involves a sacrifice on present consumption. Therefore, what we need to do is ascertain the net consumption stream of an investment project and then use the STPR.

The constituent elements of such a social time preference rate are:
- diminishing marginal utility of increasing consumption;
- pure time discount rate; and
- risk.

A simplified linear form of this model is as follows:

$$STPR = eg + m$$

Where:
- STPR = social time preference rate
- g = growth rate of real per capita income / consumption
- e = elasticity of marginal utility of income / consumption
- m = pure time discount rate

[36] **For a detailed discussion on the empirical rates and assumptions used, see: Luus C.W. and Mullins D. (2008); The Discount Rate for Cost-Benefit Analysis by the DBSA**

Based on historical per capita income and expenditure data for South Africa and global empirical research on pure discount rates, an STPR of 8.35% was arrived at in the study conducted by Luus and Mullins (2008)[37].

Considering that the second edition of the CBA manual is already recommending a real discount rate of 8 percent and that this rate is used in project evaluations in the public sector, it seems appropriate to retain 8 percent as the applicable discount rate for South Africa. Based on current evidence, the 8 percent discount rate would also be closer to the theoretically argued and calculated rates based on opportunity costs and time preferences.

7.6 Discount rate for environment purposes

Due to the long-term impact of environmental issues such as climate change and global warming on future generations, the discount rate has received renewed international interest on how discounting should be applied with regard to long-term projects, the impact of which spread over more than one generation or even hundreds of years[38].

There is little consensus in the economic literature concerning social discounting for environment purposes. Generally, relatively low discount rates are used to incorporate environmental issues in CBA analysis in developed countries. The United States EPA recommends discount rates of 2 to 3 percent for environmental analysis. On the contrary, Viscusi states that too low discount rate could make policies that damage the environment more attractive[39].

A very important aspect that should be taken into account by environmentalists that bluntly support a 2 to 3 percent real discount rate that is used more frequently by certain developed countries for the purpose of entertaining environmental issues is the fact that the developed countries experience also relative low interest rates. A crucial point to keep in mind is that the real discount rate always moves in the same direction as the bench mark long-term market interest rate (yield on 10 year bonds for example when deciding on the appropriate discount rate the level and course of the bench mark market interest rate should be taken into consideration. One should also not lose sight of the fact that International Multilateral Development Banks, which represent mostly the poorer countries, advocate higher discount rates .The fact that these countries suffer a structural capital shortage and resulting high interest rates certainly play a major role in the decision of these Development Institutions to raise their discount rates.

Weitzman (2001)[40] proposed a new theoretical approach to resolving the dilemma of a discount rate for resources that are not replaceable by the proceeds of economic growth. According to him "… society should be using effective discount

[37] For a detailed discussion on the empirical rates and assumptions used, see: Luus C.W. and Mullins D. (2008); The Discount Rate for Cost-Benefit Analysis by the DBSA
[38] Zhuang J., Liang Z., Lin T., and De Guzman F. 2007. Theory and Practice in the Choice of Social Discount Rate for Cost-benefit Analysis: A Survey. Asian Development Bank. Working paper series No. 94. p 14.
[39] Viscusi W.K. 2006. Rational Discounting for Regulatory Analysis. Working paper series Jun 2006. pp. 215-216.
[40] Weitzman ML. 2000. Gamma discounting, The American Economic Review. March 2001.

rates that decline from a mean value of, say, around 4 percent per annum for the immediate future, down to around zero for the far-distant future.

Groom (2005)[41] is also in favour of a "… discount rate which declines with time according to some predetermined trajectory, thus raising the weight attached to the welfare of future generations… and contribute to the goal of sustainable development."

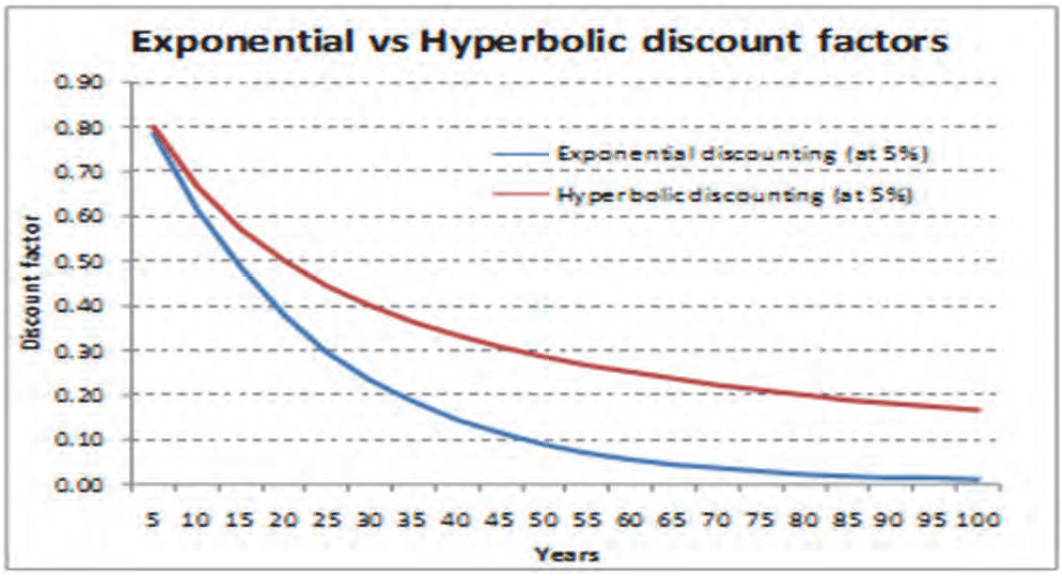
The third edition CBA manual acknowledges that there exist problems which should be addressed with regard to environmental issues in terms of their impact which only originate over the long term. The conventional discount rate method (exponential) does not accommodate these phenomena.

It is proposed that environment projects in South Africa should be discounted at the official discount rate of 8 percent, but by making use of a hyperbolic discounting factor and not the conventional discount rate (exponential). Further, it is also important that these impacts should be discounted over a longer time horizon as compared to conventional private and public sector project scenarios to properly internalise their impacts over the longer term.

The graph below portrays the difference in outcome of the exponential versus the hyperbolic discounting method. The hyperbolic discount method gives more weight to environmental issues over the long term whilst the exponential method is appropriate over the general life span of many commercial and social projects. The environmental impact is normally not that severe over the first thirty year or so of a programming period.

[41] Groom G., Hepburn C., Koundouri P. and Pearce D. 2005. Declining Discount Rates: the Long and the short of It. Environmental &Resource Economics.

Graph 1: The trend of the discount factors using exponential and hyperbolic discounting.



Source: Luus and Mullins (2008).

7.7 Shadow Prices for Labour Inputs

As was discussed under the heading of shadow prices for labour (Paragraph 2.4.3), it is highly probable that the price of labour will deviate from the marginal product of labour, and, as such, shadow prices for labour should be used to determine the correct impact of labour utilisation.

7.7.1 Unskilled labour

The full employment basis for the pricing of labour is the market price of labour for all workers. Where unemployment does exist, shadow wages are estimated for unskilled, and in some instances, semi-skilled workers. Professionals, managers and skilled labour should be valued at market prices, even where unemployment exists. The principles that apply to the determination of shadow wages are set out in detail in Paragraph 2.4.3.

The methodology used for the calculation of shadow wages for unskilled workers is discussed in Box 1.

Box 1

The source of 'official' labour market statistics in the country is the Quarterly Labour Force Survey (QLFS). The survey is compiled quarterly by Statistics South Africa (Stats SA), however, the comparatively small sample and volatility associated with quarterly sampling surveys, makes it advisable to work with annual data. Specific tables are not published by Stats SA, which means that they need to be compiled from the original data, and transformed and aggregated into the correct format.

Nine occupational groups are provided in the survey. In order to obtain a wage rate for unskilled labour, the group entitled "elementary occupation" was utilised. If labour wages are not in base-year prices (2012 in this instance), they should converted to base-year prices, with the total remuneration-per-worker in the non-agricultural sector time series available from the Reserve Bank website (code KBP7013), being used for this purpose. For example, if wage data is available in 2010 prices, the Reserve Bank index of 278.6 for 2012 should be divided by the index of 241.7 for 2010 to obtain a wage inflator. The inflator should be applied to the 2010 value to obtain wage levels in 2012 prices.

In principle, the shadow price for unskilled labourers is equal to the per-capita income in urban and non-urban areas in the various provinces, with the per-capita income of labourers being viewed as the economic value of labour. This shadow price is used as a proxy of labour's opportunity cost, i.e. the value of production lost to the economy when labour moves from an existing job to a newly created job, or from an unemployed situation to a new job.

Table 12 reflects the weekly, monthly and annual market wages for unskilled labourers by province (the data was provided by Stats SA). These shadow wages are used only where unemployment exists, and the skill levels of workers are low. If the workers for a project cannot be limited to a specific province, then the relevant national figure should be used. If sufficient information cannot be found, unemployment amongst workers involved should be viewed as insignificant. However, it should be borne in mind that unemployment amongst unskilled workers was endemic in all provinces in 2012.

For practical purposes, it is sometimes useful to work with a shadow wage rate factor, and not with nominal wage rates as such. Table 12(a) reflects the factors for adjustment of the market wage rate for unskilled labourers per province. By expressing the unskilled labour remuneration for urban and non-urban areas in each province relative to the urban wage rate in Gauteng (the most prosperous province), the shadow wage rate factors reflect the relative benefit poorer provinces and non-urban areas will receive when conducting CBA.

7.7.1.1 Skilled labour

As mentioned above, professionals, managers and skilled labour should be valued at market prices even where unemployment exists. However, for purposes of completeness and convenience the relevant remuneration for these categories are given to assist users of this manual. The methodology used for the relevant calculations is given in Box 2.

Box 2

The wage rate of skilled labour was obtained from the Labour Force Survey (LFS) 2012. Nine occupation groups were given in the survey:

- Legislators, senior officials and managers
- Professionals
- Technicians
- Office clerks
- Service, shop and market sales
- Skilled agriculture and fishing
- Crafts and related trades
- Plant and machine operators
- Elementary occupations

The first 8 groups were used as they were seen to be skilled and semi-skilled, with elementary occupations being deemed to be unskilled. If required, the same process used to inflate wage rates (see box 1) for unskilled labour should be utilised to inflate the wage rates for skilled labour.

Table 13 provides the estimated remuneration for the 8 occupational categories that make up skilled and semi-skilled labour. For purposes of this manual, occupations one and two are deemed skilled labour while occupations three to eight are deemed semi-skilled.

7.8 Foreign Exchange

The shadow price of the real effective exchange rate of the Rand (i.e. the weighted average exchange rate of the Rand against the currencies of the RSA's most important trading partners, taking into account inflation differentials) is given in Table 14. The methodology for determining the relevant rate is explained in Box 3.

Box 3

A historical series of the real effective exchange rate of the Rand (time series code KBP5378) from 1978 to 2012 was obtained from the South African Reserve Bank (SARB), with 2012 being used as the base year. A long-term time series and trend analysis was applied to the data in order to determine a long-term estimate of the direction of the real effective exchange rate of the Rand.

The long-term trend of the real effective exchange rate was then used to estimate the real effective exchange rate up to the year 2032. The trend that best fits the series implies a regressive depreciation of the real effective Rand over the long-term, which translates into an average depreciation of 0.9% per annum from 2012 to 2032, and then remains constant, as shown in Table 12.

Given the various explanatory variables (i.e. time, politics, international commodity prices, international capital flows, etc.) that play a role in influencing the exchange value of the Rand, the Rand remains volatile. The reason for this is that developments related to the variables mentioned above are unpredictable over the medium- to long-term.

The Current Account Balance of the Balance of Payments, but, more so, the movements on the Financial Account of the Balance of Payments, tend to have a profound impact on the Rand as financial flows not only reflect the investor mood, but also sentiments towards South Africa. This long term trend, nevertheless, captures the major impacts on the Rand, i.e. that of import and export volumes, forex market perceptions, foreign financial flows, the exchange value of the currencies of South Africa's most important trading partners, and inflation differentials between South Africa and its trading partners.

It is accepted that currencies in Southern Africa that are on par with the Rand will follow the same trend as the effective real exchange rate of the Rand. As such, the shadow price for foreign currencies also applies to projects in Swaziland and Lesotho.

7.9 Goods and Services (Excluding Fuel and Electricity)

The underlying principles for the valuation of inputs and outputs have been discussed in Paragraph 2.4.2. In this regard the following guidelines are provided:

(i) The opportunity costs of agricultural products traded internationally are indicated by commodity prices on world markets, as given in International Financial Statistics[42], which as issued monthly by the International Monetary Fund. For restricted imports that require permits, and to which import duties and surcharges are applied, reference is made to the Customs Tariff Book issued by Jacobsons Publishers (Pty) Limited[43] . This data is also available from Cargo Info Africa[44].

(ii) Details of goods on which excise and other domestic taxes are payable are given in the schedule to the Customs and Excise Act. As a result of ongoing adjustments made in the National Budget of the Department of Finance, it is necessary to ensure that the most recent information is obtained from the relevant Departments.

Details of goods on which VAT (Value Added Tax) is payable can be obtained from the Receiver of Revenue. An extract from the SARS publication "VAT 404 -

42 **International Financial Statistics, IMF, Washington DC.**
43 **Jacobsons Publishers (Pty) Ltd., Durban.**
44 **http://rapidttp.com/tariff/chpindx.html**

VAT Guide for Vendors"[45] , March 2013, that explains the various VAT levels for businesses is provided in Box 4.

Box 4

TAXABLE SUPPLIES

A taxable supply is any supply of goods or services by a vendor in the course of furtherance of an enterprise. Tax is charged at one of the following rates:

- Standard rate, currently 14 %
- Zero-rate (i.e. 0 %)

Standard rated supplies

As a general rule, all goods and services are standard rated unless specifically zero-rated or exempt.

Standard rated supplies are taxable supplies, taxed at the rate of 14 %. These include the supply of both goods and services that are not taxed at the rate of 0 %, or exempt. Some examples of standard rated supplies are the supply of :

- aircraft fuel
- books and newspapers
- building materials and services
- business assets sold
- cigarettes, cool drinks and liquor
- white bread
- electricity, water and refuse removals
- clothing -
- furniture
- hotel accommodation
- meat or fish
- lawyer's services
- medicines
- local aeroplane flights
- medical services (other than by State hospitals)
- transport of goods
- motor repairs
- motor vehicles and spares
- paraffin (excluding illuminating kerosene)
- postage stamps
- telephone services
- restaurant services
- washing powder
- entrance fees to sporting events

Zero-rated supplies

Zero-rated supplies are taxable supplies, taxed at a rate of 0 %. These include:

- certain foodstuffs (except when sold as a meal or refreshment)

- brown bread
- dried mealies
- brown bread flour excl. bran
- stamp
- eggs
- fresh/frozen fruit and vegetables
- maize meal
- dried beans
- lentils
- pilchards in tins or cans
- rice
- vegetable oil excluding olive oil
- milk, cultured milk, milk powder and dairy powder blend
- edible legumes and pulses of leguminous plants
- illuminating kerosene

- fuel levy goods (e.g. petrol and diesel)

[45] **South African Revenue Service. March 2013.** ***VAT 404 – Guide for Vendors (VAT 404).***

- sale of a business or part of a business as a going concern (if in writing and meeting certain requirements).
- certain services provided to foreign residents and businesses – provided goods are temporarily imported for modification, service or repair and the importer furnishes you with a VAT 262 form which has been completed and certified by the Controller of Customs
- direct exports (See Chapter 10 of VAT 404 VAT Guide for Vendors)

DEEMED SUPPLIES

As a registered vendor, you may sometimes be required to pay output tax even though you have not supplied any goods or services. These are called deemed supplies.

Circumstances that will give rise to deemed taxable supplies include the following:

- goods/services taken for own use
- certain fringe benefits to staff
- assets retained at the time of deregistering as a vendor
- Short-term insurance claims that have been paid to you in respect of your business (e.g. insurance pay-out received for damaged stock.
- subsidies or grants received from the State
- goods acquired under an instalment credit agreement that have been repossessed from you

EXEMPT SUPPLIES

Exempt supplies are supplies of goods or services on which VAT is not chargeable at either the standard rate or the zero-rate and do not form part of your taxable turnover. If you make only exempt supplies, you may not register as a vendor for VAT purposes. VAT incurred on any expenses in order to make exempt supplies may not be claimed as an input tax credit.

Exempt supplies include the following:

- financial services (interest, life insurance, medical schemes, provident, pension and retirement annuity funds)
- donated goods or services sold by non-profit bodies (e.g. church bazaars)
- renting a dwelling for use as a private home (but not holiday accommodation)
- passenger transport in South Africa by taxi, bus or train
- educational services (crèches, primary and secondary schools, universities, technikons and other institutions registered under an educational Act.)

The prices of services provided by Transnet and the Post Office are determined administratively. Since the prices of many of Transnet's services are supposed to be market-related, and the new national transport policy in the RSA allows for free competition between the different modes of transport, the difference between market-determined and controlled prices for land transport should gradually disappear. Therefore, as the public transport component of most projects is fairly small, it is doubtful whether the calculation of shadow prices for this purpose is necessary. It may, however, be important where the transport content of a project is high, or where a decision has to be made concerning the establishment of transport infrastructure.
The same approach should be adopted in respect of services delivered by the Post and Telecommunication services.

7.10 Shadow Fuel Prices

The shadow price of fuel is the pump price of fuel, minus levies and taxes that do not directly benefit the fuel consumer. As such, taxes that can be viewed as consumer levies on roads are included, while other general fuel taxes that are used to the benefit of other general public services are excluded.

The shadow price of farm diesel differs from the shadow price of diesel for road transport in that the user levies for roads and vehicle accident insurance are

excluded. The diesel rebate for farmers includes the refund on diesel for farming purposes.

The shadow price of diesel used for construction purposes differs from the road transport diesel price in that the construction diesel price excludes the Road Accident Fund (RAF) levy and government expenditure on roads.

General government (including national, provincial and local tiers of government) recurrent expenditure on roads includes spending on road maintenance, traffic management and road safety. Dividing the above mentioned recurrent expenditure on existing roads with the volume of fuel consumed by road traffic users reflects the spending-per-litre of fuel consumed, which is about 67 cents per litre.

The composition of the pump price of diesel and petrol was obtained from the Department of Minerals and Energy website in Pretoria[46].

The calculated shadow prices for petrol and diesel must further be adjusted for transport costs according to magisterial districts. Table 15 provides shadow prices for the various types of fuel in price zone 9C, Gauteng. In order to calculate shadow prices for the other provinces, a transport adjustment factor must be calculated according to magisterial district. Table 16 provides a list of these adjustment factors, which were calculated relative to zone 9C (Gauteng). The magisterial districts and the zones in which they appear are indicated in Appendix 2.

Table 17 can be used for estimating fuel prices in future. This index is based on the projection for crude oil prices from 2012 to 2032 assuming a rate of increase similar to expected global inflation, a perspective on the Rand/Dollar exchange rate of the Rand (using the same methodology explained in Box 3) and an extrapolation of fuel taxes (available from the Department of Minerals and Energy's website. All other costs that are part of the pump price of fuel remain constant. For an alternative view on projected crude oil prices see the websites of the World Bank and the International Monetary Fund (IMF).

7.11 Electricity Prices

Eskom's tariffs are based in part on historical costs, and hence do not necessarily fully reflect the opportunity cost that is entailed in providing electricity to users. Consequently, it is necessary to calculate a shadow price for electricity.

Electricity tariffs are comprised of generation, transmission and distribution costs. Currently, demand and supply are in close match, however, future user demand for electricity is expected to increase significantly, with the result that it is imperative that new electricity generation plants will have to be constructed, which will cause an increase in generation costs.

[46] **Department of Minerals and Energy, Press Release, 4 July 2012, Pretoria.**

In view of the envisaged expansion by Eskom (the main supplier of electricity in South Africa), projections of the relative price movements for electricity will have to be made. Eskom is the midst of a major expansion programme that started in 2005 and aims to add 17GW of much-needed electricity-generating capacity by 2018/19. An estimation of the probable real (above inflation) tariff increases for electricity that will be required to service and repay these capital outlays over twenty years implies real increases in Eskom's tariffs.

On 28 February the National Energy Regulator of South Africa (NERSA) granted Eskom yearly increases of 8% for the third multiyear price determination (MYDP3) period from 2013/14 to 2017/18 instead of the 16% increases requested by Eskom. In real terms, assuming an inflation rate of 5%, the annual increase granted will come to 3%. These increases must be included in the shadow price of electricity.

In a report prepared for the Development Bank of Southern Africa[47], the consultants emphasised that funding options could have far-reaching repercussions for economic growth and development. The baseline funding option identified in the report envisage funding made up of 60.6% by loans, 30% of state equity in the form of annual capital transfers to Eskom in order to strengthen its equity and 9.4% in the form of a social grant from the Fiscus to make good for the losses as a result of households who cannot pay. This scenario implies an increase in electricity tariffs of 3.7% above inflation on an annual basis for the period 2011 – 2025. Other options developed in the report result in higher tariffs.

Table 18 provides the estimated relative real tariff movements of the generation and distribution of electricity in the form of an index. We have used Eskom's projected tariff increases as allowed for by the MYDP3, fully aware that risks as recently expressed by Standard and Poor's (S&P) are on the upside. The credit rating agency has affirmed Eskom's credit rating at BBB, however downgraded Eskom's Stand Alone Credit Profile by one notch to 'b-' from 'b', due to the revised business risk profile from "fair" to "weak". This action was taken primarily in light of increased regulatory and operating risk, and weakened profitability owing to an unfavourable regulatory decision. S&P believes that Eskom will require additional funding of R50 bn in the outer years of MYDP3.

The index should be applied to the existing electricity tariff over the period of the project being evaluated in order to make provision for changes in relative movements in electricity tariffs. In the relevant calculations, provision has been made so that only generation costs will increase. Therefore, the index in Table 18 should be applied to total electricity costs.

7.12 Surrogate Prices

7.12.1 Value of time

[47] **Guidelines/Principles for the Optimal Provision of Electricity in South Africa – an Economic Growth and Development Perspective. Report prepared for the Development Bank of Southern Africa by Conningarth Economists 2010.**

Table 19 provides an estimate of the value of time per working and recreational hour for low, middle and high income groups in each province, as well as the value of time for all workers, expressed in 2012 prices. The relevant methodology is discussed in Box 5.

Box 5

•The average provincial annual remuneration for 9 occupational categories (see Table 11) served as the basis for the calculations for Table 17. The figures for these 9 categories were aggregated to represent high, middle and low remuneration groups, with "legislators, senior officials, managers" and "professionals" being classified in the high income group, whereas the "elementary occupations" was assumed to represent the low income groups. The remaining categories were then aggregated to form the middle income group.

•The value of a working hour per income group in each province (see column 1 in Table 17) was obtained by dividing the average for a specific income group by the total number of working hours for that group per annum. The total number of working hours per year was calculated as the product of the total number of weeks (52), and the average number of working hours per week (40). The result was 2 080 hours, which was rounded off to 2 000 hours in order to take into account that not all workers are fully employed on a yearly basis.

•The value of a recreational hour for workers per income group per province (column 3) was calculated as the value of a working hour per income group, divided by the total number of hours per annum, i.e. 365.25 days times 24 hours, which equals 8 766 hours.

•In order to calculate the provincial value of a recreational hour for all persons (see column 2 of Table 17), a dependency ratio per income group in each province was required. The Labour Force Survey of 2012 provides the basic information from which a dependency ratio per province for the total population could be calculated. The methodology for obtaining the dependency ratios per income group is explained below. As the same method was followed for each province, only the method for the Western Cape Province will be explained.

•The Labour Force Survey provides, on a race basis, the number of people working in each occupational group in each province. The total population per race group per province can be sourced from Stats SA's Mid-year Population Estimates (P0302) or from Census 2011 data. By dividing the total population (per race group) in the Western Cape by the total number of employed individuals (per race group) in the province, the dependency ratio per race group was obtained.

•From the Labour Force Survey, the number of people employed in each of the nine occupation could be aggregated into a high medium and low income category:

1) High income category: legislators, managers, and professionals.
2) Low income category: elementary occupations.

3) Middle income category: The rest of the occupation categories fell into the middle income group.

The percentage distribution of black, coloured, Indian and white was obtained across the three income groups. The dependency ratio calculated per race group was multiplied with the equivalent race group's distribution per income level to arrive at a weighted dependency ratio for each income level. The dependency ratio for the Western Cape is illustrated below.

	Dependency ratio
Low	3.94
Middle	3.90
High	3.86

The value of a recreational hour for all persons was then obtained by dividing the value of a recreational hour for workers in each income group by the relevant dependency ratio per income group. As mentioned above this process was then repeated for each province, and for South Africa as a whole.

For forecasting purposes, the values in Table 19 should be viewed as constant real values. The value of time for recreation is only used if time saved or lost could include the productivity of workers, irrespective of the fact that it is not in working time. An example of this is the time a worker spends in travelling to or from work. In all the other instances, the price of workers' time for recreation is the same as the time for recreation for all persons.

7.12.2 Input data for the economic evaluation of road infrastructure projects and cost of collisions

Road vehicle running cost, the cost of travel time and the cost of road collisions are critical input variables in determining the economic feasibility of proposed investments in road infrastructure. In this regard, a useful tool is the Highway Development and Management (HDM-4) software that was developed in the late 1960s under the auspices of the World Bank, which has been constantly improved and expanded since. It is currently being managed by HDM Global.

According to McPherson and Bennett (p39) [48] , "HDM-4 is a tool for economic optimisation of maintenance of road networks and has been adopted or applied in many different countries for economic analysis and prioritisation. HDM-4 can operate with Strategy, Program and Project analysis. It utilises road network inventory and condition data, traffic data, and economic data to feed a series of road deterioration models and cost models, and to formulate candidate work programs for road networks." The focus and scope of the strategy analysis, the programme analysis and the project analysis are described in Box 6 below.

[48] **McPherson, Kevin and Bennett, Christopher, R, 2005. Success factors for Road Managmeent Systems. East Asia Pacific Transport Unit, the World Bank, Washington DC.**

Box 6

Strategy analysis:

Typical examples of strategy analysis by road agencies would include the following:

- Medium to long term forecasts of funding requirements for specified target road maintenance standards.
- Forecasts of long term road network performance under varying levels of funding.
- Optimal allocation of funds according to defined budget heads; for example routine maintenance, periodic maintenance and development (capital) budgets.
- Optimal allocations of funds to sub-networks; for example by functional road class (main, feeder and urban roads, etc.) or by administrative region.
- Policy studies such as impact of changes to the axle load limit, pavement maintenance standards, energy balance analysis, provision of NMT facilities, sustainable road network size, evaluation of pavement design standards, etc." (Kerali, p13-14).

Programme analysis:

Programme analysis "… deals primarily with the prioritisation of a defined long list of candidate road projects into a one-year or multi-year work programme under defined budget constraints" (Kerali, p17[49]).

Project analysis:

Project analysis deals with the "…evaluation of one or more road projects or investment options. The application analyses a road link or section with user-selected treatments, with associated costs and benefits, projected annually over the analysis period. Economic indicators are determined for the different investment options" (Kerali, p19). Projects may typically include "…the maintenance and rehabilitation of existing roads, widening or geometric improvement schemes, pavement upgrading and new construction" (Kerali, p19).

HDM-4 is increasingly being used internationally as the preferred tool for road project evaluation in both developing and developed countries. It contains all of the required datasets needed to perform an analysis. It is, however, important that datasets should be calibrated first to local (South African) conditions so as to ensure reliable results.

[49] **Kerali, Henry, G.R., 2000. Overview of HDM-4, Volume 1. The World Road Association (PIARC), Paris.**

For low volume road projects, the World Bank's RED (Roads Economic Decision) model (using many of the relationships of HDM-4) can be used. As with HDM-4, datasets in RED must first be calibrated to South African conditions.

7.12.3 Economic value of a life in terms of future productive potential

Table 20 provides estimates of the economic value of a human life for different income groups in terms of their future productive potential based on their future wealth per annum, and on remaining life expectancy. The table provides the value of a human life per annum, as well as the capitalised value of the expected remaining lifetime for the relevant person. This is calculated by discounting the wealth per annum by 8% over the remaining lifetime. The relevant methodology is explained in Box 6.

Box 7

The economic value of a human life in terms of future productive potential consists of the annual wealth, and the relevant person's remaining life expectancy. The economic life is calculated by discounting the economic value over the remaining life expectancy by using an 8% discount rate.

	NPV 8%	Total	Year 1	Year 2	Year 3
Low income person	R104 822	R252 247	R8 698	R8 698	R8 698
Medium income person	R252 461	R685 932	R20 174	R20 174	R20 174
High income person	R799 950	R2 275 716	R63 214	R63 214	R63 214
Average	R355 352	R971 610	R28 577	R28 577	R28 577
Total	R1 514 840	R4 185 504	R120 664	R120 664	R120 664

Annual wealth is based on the value per recreational hour for all persons in Table 17. In order to express this value on an annual basis, it is multiplied by 8 766 hours (365.25 days per annum, multiplied by 24 hours per day)

In order to capitalise this wealth value over the expected remainder of a life it is necessary to calculate the remaining lifetimes in the three income categories. The basis for the life expectancy per income group is the life expectancy per population group as published by Stats SA as a statistical release "Mid-year Population Estimates 2013" (report P0302).

Life expectancies at birth:

	Average life expectancy
Africans	55.8
Coloureds	64.0
Indians	68.5
Whites	72.5

According to Stats SA data, life expectancy at birth had declined between 2002 and 2005 but has since increased partly due to the roll-out of antiretrovirals in combating the effect of HIV-AIDS.

The 2012 age levels per population group were calculated by using the Stats SA statistical release "Mid-year Population Estimates 2013" (report P0302).

	Average age level
Africans	26.52
Coloureds	29.20
Indians	32.47
Whites	38.46

In order to calculate the remaining life period for these population groups, the difference between the average life expectancy and the 2012 age structure was calculated. The results are as follows:

	Average remaining life expectancy
Africans	29.28
Coloureds	34.80
Indians	36.03
Whites	34.04

For the purposes of this CBA Manual, it was necessary to convert the results for the population groups to income groups. The population per income group was already available from the value of time calculations. The source for this information was the Quarterly Labour Force 2012, where the population per occupation was given. As explained under the value of time, the occupational groups were aggregated to get the low, medium and high income groups.

This information was used, in the form of weights, to convert the life expectancies from population groups to income categories. The remaining life period for the various income groups are as follows:

	High	Medium	Low
Expected Economic lifetime	32.45	30.89	30.11

If a specific age category is used, e.g. children or the aged, the remaining expected life in years should be used for purposes of calculating the relevant capitalised wealth.

The value reflected here is merely an indication of the economic value in terms of future productive potential of a person, and is an indication of the real value of human life in South Africa society. When human lives are under discussion, the number of lives involved should be pointed out in addition to the economic value of a life. This is essential to give the decision-maker a complete picture of the implications of his/her proposed decision so far as it relates to the preservation and protection of human lives.

Table 12: Estimated Remuneration for Unskilled Labourers per Province [Rands]

Provinces	Market wage in 2012 prices[1)]					
	WEEK		MONTH		YEAR	
	Urban	Non-urban	Urban	Non-urban	Urban	Non-urban
Western Cape	771	459	3 084	1 837	37 006	22 048
Eastern Cape	611	357	2 442	1 429	29 307	17 153
Northern Cape	508	357	2 032	1 430	24 390	17 156
Free State	628	383	2 512	1 530	30 148	18 360
KwaZulu-Natal	705	392	2 822	1 568	33 863	18 810
North West	739	722	2 957	2 888	35 480	34 661
Gauteng	1 153	630	4 611	2 519	55 332	30 234
Mpumalanga	955	473	3 820	1 891	45 835	22 690
Limpopo	573	531	2 291	2 126	27 494	25 509
Total	854	469	3 418	1 875	41 014	22 494

Whenever another base year is used, the above figures must be adjusted using the index for labour costs in the non-agricultural sectors, contained in the Reserve Bank Bulletin.
When using wages for unskilled labour the wages in table 10 should be adjusted by the shadow factor in Table 12(a).

Table 12(a): Factors for Adjustment of the Market Wage Rate for Unskilled Labourers per Province [Rands]

Provinces		
	Urban	**Non-urban**
Eastern Cape	0.67	0.40
Free State	0.53	0.31
Gauteng	0.44	0.31
KwaZulu-Natal	0.54	0.33
Mpumalanga	0.61	0.34
Northern Cape	0.64	0.63
Limpopo	1.00	0.55
North West	0.83	0.41
Western Cape	0.50	0.46

Table 13: Estimated Annual Remuneration for Occupational Categories in South Africa per Province [Rands, 2012 Prices]

	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo
Legislators, senior officials & managers	229 390	211 926	188 872	191 186	154 062	248 659	238 196	270 648	178 568
Professionals	269 144	226 437	193 983	174 496	165 611	163 687	266 226	210 837	183 514
Technicians	149 289	117 071	109 356	111 468	103 089	128 299	116 339	106 869	130 325
Office clerks	96 630	67 054	74 286	62 851	72 871	81 161	94 595	85 377	72 240
Service, shop & market sales	65 042	44 751	50 586	57 531	54 791	60 202	71 730	51 208	39 639
Skilled agricultural and fishing	47 263	27 283	58 809	15 959	21 648	66 046	41 156	21 993	27 581
Crafts & related trades	61 094	59 269	60 509	53 464	56 729	74 408	79 771	96 396	65 568
Plant & machine operators	52 639	47 785	38 543	45 785	47 051	59 349	58 584	69 415	50 626
Elementary occupations	33 598	24 933	22 080	27 073	26 729	35 059	54 620	31 429	25 775

Table 14: Index of Projected Real Effective Exchange Rate of the Rand

	Foreign
Year	**Exchange**
	Index
2005	100.00
2006	99.09
2007	98.18
2008	97.26
2009	96.35
2010	95.44
2011	94.53
2012	93.62
2013	92.71
2014	91.79
2015	90.88
2016	89.97
2017	89.06
2018	88.15
2019	87.23
2020	86.32
2021	85.41
2022	84.50
2023	83.59
2024	82.68
2025	81.76
and	
beyond	

Table 15: Shadow Price in Cent for Petrol and Diesel on 4 July 2012 for Gauteng Zone 9C

Components	Petrol 93 ULP	Diesel Price		
		Road Transport	Construction	On-Farm Use
Pump price	1061.00	1010.97	1010.97	1010.97
Minus: Total taxes and levies included in pump price	289.50	274.50	186.50	265.50
- Fuel taxes	197.50	182.50	182.50	182.50
- Custom and excise	4.00	4.00	4.00	4.00
- Farming rebate*	0.00	0.00	0.00	79.00
- RAF (road accident fund) levy	88.00	88.00	0.00	0.00
Plus: Road related taxes and levies	154.89	181.65	0.00	0.00
- RAF	88.00	88.00	0.00	0.00
- Expenditure on roads	66.89	93.65	0.00	0.00
	0.00	0.00	0.00	0.00
Shadow price	926.39	918.12	824.47	745.47
Shadow factor	0.87	0.91	0.82	0.74

Source: Department of Minerals and Energy

The RAF levy has been increased by 20% to make provision for the underfunding of the RAF.

Expenditure on roads for road transport was increased by 30% to make provision for the non-proportional impact on roads by heavy vehicles.

Table 16: Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (July 2012)												
Price Zone	Lead replacement petrol		Adjustments in cents		Unleaded petrol		Adjustments in cents		Diesel			
									Wholesale Price		Adjustment in cents	
	93 Octane	95 Octane	93	95	93 Octane	95 Octane	93	95	0.05% Sulphur	0.005% Sulphur	0.05% Sulphur	0.005% Sulphur
1A	1036	1047	-25	-35	1036	1047	-25	-25	986.3	991.7	-24.7	-24.7
2A	1039	1050	-22	-32	1039	1050	-22	-22	989.6	995.0	-21.4	-21.4
3A	1042	1053	-19	-29	1042	1053	-19	-19	992.6	998.0	-18.4	-18.4
4A	1046	1057	-15	-25	1046	1057	-15	-15	996.5	1001.9	-14.5	-14.5
5A	1052	1063	-9	-19	1052	1063	-9	-9	1002.0	1007.4	-9.0	-9.0
6A	1060	1071	-1	-11	1060	1071	-1	-1	1009.9	1015.3	-1.1	-1.1
7A	1067	1078	6	-4	1067	1078	6	6	1016.9	1022.3	5.9	5.9
8A	1080	1091	19	9	1080	1091	19	19	1030.3	1035.7	19.3	19.3
9A	1094	1105	33	23	1094	1105	33	33	1044.4	1049.8	33.4	33.4
10A	1103	1114	42	32	1103	1114	42	42	1053.1	1058.5	42.1	42.1
11A	1107	1118	46	36	1107	1118	46	46	1057.2	1062.6	46.2	46.2
13A	1108	1119	47	37	1108	1119	47	47	1058.2	1063.6	47.2	47.2
15A	1105	1116	44	34	1105	1116	44	44	1054.8	1060.2	43.8	43.8
17A	1117	1128	56	46	1117	1128	56	56	1067.4	1072.8	56.4	56.4
19A	1123	1134	62	52	1123	1134	62	62	1073.1	1078.5	62.1	62.1
57A	1067	1078	6	-4	1067	1078	6	6	1016.9	1022.3	5.9	5.9
69A	1123	1134	62	52	1123	1134	62	62	1073.1	1078.5	62.1	62.1

Source: Department of Minerals and Energy, 2012, Press release, Pretoria

Table 16 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel according to Magisterial Districts

Price in cents per litre (July 2012)												
Price Zone	Lead replacement petrol		Adjustments in cents		Unleaded petrol		Adjustments in cents		Diesel			
									Wholesale Price		Adjustment in cents	
	93 Octane	95 Octane	93	95	93 Octane	95 Octane	93	95	0.05% Sulphur	0.005% Sulphur	0.05% Sulphur	0.005% Sulphur
3B	1047	1058	-14	-24	1047	1058	-14	-14	997.0	1002.4	-14.0	-14.0
5B	1054	1065	-7	-17	1054	1065	-7	-7	1004.3	1009.7	-6.7	-6.7
6B	1050	1061	-11	-21	1050	1061	-11	-11	1000.1	1005.5	-10.9	-10.9
7B	1057	1068	-4	-14	1057	1068	-4	-4	1006.9	1012.3	-4.1	-4.1
8B	1065	1076	4	-6	1065	1076	4	4	1015.1	1020.5	4.1	4.1
9B	1063	1074	2	-8	1063	1074	2	2	1013.4	1018.8	2.4	2.4
10B	1071	1082	10	0	1071	1082	10	10	1021.2	1026.6	10.2	10.2
12B	1074	1085	13	3	1074	1085	13	13	1024.1	1029.5	13.1	13.1
14B	1081	1092	20	10	1081	1092	20	20	1030.9	1036.3	19.9	19.9
5C	1042	1053	-19	-29	1042	1053	-19	-19	991.9	997.3	-19.1	-19.1
6C	1054	1065	-7	-17	1054	1065	-7	-7	1004.2	1009.6	-6.8	-6.8
7C	1059	1080	-2	-2	1059	1070	-2	-2	1009.4	1014.8	-1.6	-1.6
8C	1063	1084	2	2	1063	1074	2	2	1013.3	1018.7	2.3	2.3
9C	1061	1082	0	0	1061	1072	0	0	1011.0	1016.4	0.0	0.0
10C	1070	1091	9	9	1070	1081	9	9	1019.9	1025.3	8.9	8.9

Source: Department of Minerals and Energy, 2012, Press release, Pretoria

Table 16 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (July 2012)												
Price Zone	Lead replacement petrol		Adjustments in cents		Unleaded petrol		Adjustments in cents		Diesel			
									Wholesale Price		Adjustment in cents	
	93 Octane	95 Octane	93	95	93 Octane	95 Octane	93	95	0.05% Sulphur	0.005% Sulphur	0.05% Sulphur	0.005% Sulphur
11C	1082	1103	21	21	1082	1093	21	21	1032.5	1037.9	21.5	32.4
12C	1087	1108	26	26	1087	1098	26	26	1037.0	1042.4	26.0	36.9
13C	1097	1118	36	36	1097	1108	36	36	1047.4	1052.8	36.4	47.3
14C	1110	1131	49	49	1110	1121	49	49	1060.2	1065.6	49.2	60.1
15C	1099	1120	38	38	1099	1110	38	38	1049.4	1054.8	38.4	49.3
16C	1100	1121	39	39	1100	1111	39	39	1049.8	1055.2	38.8	49.7
17C	1110	1131	49	49	1110	1121	49	49	1060.0	1065.4	49.0	59.9
57C	1059	1070	-2	-12	1059	1070	-2	-2	1009.4	1014.8	-1.6	9.3
58C	1063	1074	2	-8	1063	1074	2	2	1013.3	1018.7	2.3	13.2
60C	1070	1081	9	-1	1070	1081	9	9	1019.9	1025.3	8.9	19.8
61C	1082	1093	21	11	1082	1093	21	21	1032.5	1037.9	21.5	32.4
62C	1087	1098	26	16	1087	1098	26	26	1037.0	1042.4	26.0	36.9
63C	1097	1108	36	26	1097	1108	36	36	1047.4	1052.8	36.4	47.3
64C	1110	1121	49	39	1110	1121	49	49	1060.2	1065.6	49.2	60.1
67C	1110	1121	49	39	1110	1121	49	49	1060.0	1065.4	49.0	59.9
31J	1081	1092	20	10	1081	1092	20	20	1031.1	1036.5	20.1	31.0

Source: Department of Minerals and Energy, 2012, Press release, Pretoria

Table 16 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (July 2012)												
Price Zone	Lead replacement petrol		Adjustments in cents		Unleaded petrol		Adjustments in cents		Diesel			
									Wholesale Price		Adjustment in cents	
	93 Octane	95 Octane	93	95	93 Octane	95 Octane	93	95	0.05% Sulphur	0.005% Sulphur	0.05% Sulphur	0.005% Sulphur
32J	1098	1109	37	27	1098	1109	37	37	1047.8	1053.2	36.8	47.7
33J	1107	1118	46	36	1107	1118	46	46	1057.0	1062.4	46.0	56.9
34J	1106	1117	45	35	1106	1117	45	45	1055.8	1061.2	44.8	55.7
35J	1109	1120	48	38	1109	1120	48	48	1059.0	1064.4	48.0	58.9
36J	1109	1120	48	38	1109	1120	48	48	1059.0	1064.4	48.0	58.9
37J	1117	1128	56	46	1117	1128	56	56	1067.3	1072.7	56.3	67.2

Source: Department of Minerals and Energy, 2012, Press release, Pretoria

Table 17: Index of Projected Prices for Petrol and Diesel (2012 = 100)

	Real		Nominal *	
Year	Petrol 93 ULP	Diesel	Petrol 93 ULP	Diesel
2012	100	100	100	100
2013	97	96	102	101
2014	106	104	117	115
2015	107	106	124	122
2016	111	109	135	133
2017	115	113	147	145
2018	119	118	160	158
2019	124	122	175	172
2020	129	127	190	188
2021	134	132	207	205
2022	139	137	226	223
2023	144	142	247	243
2024	150	148	269	265
2025	155	153	293	289
2026	161	159	319	315
2027	168	165	348	343
2028	174	172	380	374
2029	181	178	414	408
2030	188	185	451	445
2031	195	192	492	485
2032	202	199	536	529
and				
beyond				

(*) Estimated CPIX inflation of 5% per annum.

Table 18: Index (2012 = 100) of Estimated Increase In Electricity Tariffs above CPI Inflation

Year	Shadow price index
2012	100
2013	108
2014	113
2015	133
2016	141
2017	150
2018	160
2019	171
2020	182
2021	195
2022	208
2023	221
2024	236
2025	252
2026	268
2027	286
2028	305
2029	325
2030	346
2031	369
2032	394
and	
beyond	

Table 19: Estimated Time Cost According to Income Groups in 2012 Prices

	1	2	3
	Value of a working hour	**Value per recreational hour for all persons**	**Value of recreational hour for workers**
Income group			
	(Rand)	**(Rand)**	**(Rand)**
Eastern Cape			
Low income group	12.47	0.36	2.84
Middle income group	30.27	1.02	6.91
High income group	109.59	5.24	25.00
Total population	45.92	1.53	10.48
Free State			
Low income group	13.54	0.59	3.09
Middle income group	28.92	1.32	6.60
High income group	91.42	4.67	20.86
Total population	41.10	1.87	9.38
Gauteng			
Low income group	27.31	1.45	6.23
Middle income group	38.51	2.21	8.79
High income group	126.11	8.06	28.77
Total population	56.73	3.27	12.94

Table 19 (continue): Estimated Time Cost According to Income Groups in 2012 Prices

	1	2	3
	Value of a working	**Value per recreational**	**Value of recreational**
Income group	**hour**	**hour for all persons**	**hour for workers**
	(Rand)	**(Rand)**	**(Rand)**
Kwazulu-Natal			
Low income group	13.36	0.50	3.05
Middle income group	29.68	1.24	6.77
High income group	79.92	4.21	18.23
Total population	39.03	1.62	8.91
Mpumalanga			
Low income group	15.71	0.58	3.59
Middle income group	35.94	1.38	8.20
High income group	120.37	5.11	27.46
Total population	52.45	2.01	11.97
Northern Cape			
Low income group	11.04	0.49	2.52
Middle income group	32.67	1.51	7.45
High income group	95.71	4.84	21.84
Total population	44.28	2.03	10.10

Table 19 (continue): Estimated Time Cost According to Income Groups in 2012 Prices

Income group	Value of a working hour (Rand)	Value per recreational hour for all persons (Rand)	Value of recreational hour for workers (Rand)
Limpopo			
Low income group	12.89	0.37	2.94
Middle income group	32.16	0.96	7.34
High income group	90.52	3.01	20.65
Total population	42.99	1.28	9.81
North West			
Low income group	17.53	0.61	4.00
Middle income group	39.12	1.41	8.93
High income group	103.09	3.94	23.52
Total population	50.94	1.83	11.62
Western Cape			
Low income group	16.80	0.97	3.83
Middle income group	39.33	2.30	8.97
High income group	124.63	7.36	28.44
Total population	55.78	3.26	12.73

Table 19 (continue): Estimated Time Cost According to Income Groups in 2012 Prices

Income group	Value of a working hour (Rand)	Value per recreational hour for all persons (Rand)	Value of recreational hour for workers (Rand)
AVERAGE			
Low income group	15.63	0.65	3.57
Middle income group	34.07	1.52	1.30
High income group	52.30	5.56	23.86
Total population	47.69	2.13	10.88
* In terms of 2012 prices, a worker earns about :			
R 0.00 - R 54 620 in the low income category,			
R 54 621 - R 149 289 in the middle income category and			
R 78488 and more in the high income category.			
** Remaining life expectancies of persons in the following income groups are as follows:			
	Low:	30.55	years
	Middle:	30.92	years
	High:	30.74	years
	Average:	30.07	years
*** Whenever another base year is used, the above figures must be adjusted using to consumer price index.			

Table 20: Economic Value of Life in 2012 prices (Rand)

Income group	Value of a life per year	Discounted life-time value of an average person	
Low	8 698	R 106 620	
Middle	20 174	R 256 563	
High	63 214	R 799 950	
Average	28 577	R 355 352	
* In terms of 2012 prices, a worker earns about :			
R 0.00 - R 54620 in the low income category,			
R 54621 - R 149289 in the middle income category and			
R 78488 and more in the high income category.			
** Remaining lifespan of persons in the following income			
groups are as follows:			
	Low:	30.11	years
	Middle:	30.89	years
	High:	32.45	years
	Average:	31.15	years
*** Whenever another base year is used, the above figures			
must be adjusted using to consumer price index.			

CHAPTER 8: ISSUES RELATING TO WATER RESOURCE DEVELOPMENT

In this chapter various issues relating to water resource development will be discussed. In most cases the discussions should only be viewed as guidelines to address a problem and not as prescribed rules for CBA.

8.1 Issues Relating to the Cost of Water Resource Development

In this section three aspects will be discussed which form the building blocks for calculating the cost of water resource development.

8.1.1 Water development and river basin management cost

South Africa is in the process of establishing a water pricing strategy.

On 12 November 1999 the South African Government published their raw water pricing strategy. This strategy is based on the principle that a specific catchment's revenue should pay for the delivery cost of the relevant water. This is in line with the basic costing principles set out in the manual for capturing the financial and opportunity cost (economic cost).

The objectives of the pricing strategy can be summarised as:

- **Social Equity**

Redressing the imbalances of the past with respect to:

  - inequitable access to basic water services at affordable tariffs within municipal areas, by facilitating a conditional subsidy on raw water cost where stepped tariffs are introduced
  - inequitable access to water for productive use purposes by subsidising tariffs for emerging farmers for a limited time period.

- **Ecological Sustainability**

Pricing will take account of the cost of:

  - safeguarding the ecological reserve
  - the ecological management of the catchment
  - water quality protection
  - water conservation and use management

- **Financial Sustainability**

Generating adequate revenue for funding the annual cost related to:

  - the management of water resources
  - the operation and maintenance of existing schemes
  - the rehabilitation of existing schemes
  - the development of augmentation schemes

In the process of annual tariff increases to reach this objective, the constraints within various user sectors to adapt to price increases will be taken into account.

- Economic Efficiency

  - To promote the efficient allocation and beneficial use of water, water should be priced at its opportunity cost.
  - The Pricing Strategy provides for administrative as well as market-related measures to achieve this goal.

The nucleus of the policy is based on the principle of user charges. Cost allocations to user types (sectors) are as follows:

- Water resource management activity costs must be allocated to sectors in proportion to volumetric average annual sectoral use.
- Registered sectoral water use will take into account the assurance of supply from State and Water Use Authority (WUA) schemes.
- The Pricing Strategy determines that the following activity costs must not be allocated to the Forestry sector.
  - Dam safety control
  - "Working for Water" (WfW) programme in South Africa

The specific setting of sectoral charges will take into account the following:

- Unit costs per sector will be determined for each Water Management Area (WMA) by dividing budgeted activity costs by the allocable sectoral use.
- Unit charges in cents per m3 for pricing purposes will take into account the subsidies granted i.r.o. the Pricing Strategy.
- The WFW unit cost for irrigation is subsidised by 90 %.
- In under-utilised WMAs the charges are based on allocatable water and the under-recovery in revenue is subsidised by DWAF.

In Table 21 an example is given of the calculation of water costs for various users in 2012 prices. It should be noted that this is only an example which is not to be used in actual CBA calculations.

Table 21: Summary of Calculation of the Water Costs for a Typical River Basin

Dam Unit Cost	Current 2012
Domestic and Industrial	
Return on asset cost c/m^3	11.27
Depreciation cost c/m^3	0.81
Betterments cost c/m^3	0.00
Operation and maintenance cost c/m^3	1.50
Functional support cost c/m^3	0
Infrastructure cost c/m3	13.58
Catchment management cost c/m3	0.06
Working for water cost c/m^3	0.04
Afforestation/Abstraction cost c/m^3	0.02
Total unit cost c/m^3	13.69
Irrigation (full quota: 11000m^3/ha)	0
Betterments cost R/ha	0.00
Operation and maintenance cost R/ha	223.77
Functional support cost R/ha	0
Infrastructure cost R/ha	223.77
Catchment management cost R/ha	2.96
Working for water cost R/ha	0.56
Afforestation/Abstraction cost R/ha	2.40
Sub Total	230
10% increase into SAAU Agreement	22.97
Total unit cost R/ha	252.66
Total unit cost c/m^3	2.30

8.1.2 Opportunity cost of water

Water is a scarce resource in South Africa. In most of the drainage regions an additional demand of water implies that there is not only storage and transfer cost involved but also an economic cost (opportunity cost). This is due to the fact that this additional water demand in some cases deprives a current or a future user of water. For example, only in a few water catchments in South Africa, where water in the low flow periods is still adequate, and forestry permits are issued readily, which attest to the scarcity of water. This example supports the opportunity cost argument.

In addition to the cost calculations proposed by the above-mentioned raw water pricing strategy, the opportunity cost of water should also be taken into

consideration. In theory the opportunity cost of water in a specific catchment is equal to the application with the highest economic use of water. This will differ from catchment to catchment.

Internationally and also in South Africa the economic value of water for industrial and urban use is much higher than the economic value of water for irrigation and forestry use. The practical implication of this is that in the event of a shortage of water for industrial and urban use, water will be channelled away from irrigation and forestry in favour of industrial and urban water use. In such a case the economic value of water for industrial and urban use should at least be equal to the economic cost to the country (the so-called opportunity cost) of reduced forestry and/or irrigation activity.

8.1.2.1 Application of opportunity cost

The opportunity cost should be added to the water development and river basin management cost of water as proposed by the raw water strategy (See paragraph 7.1.1) to obtain the full cost of water for a specific catchment. It is important to note that the opportunity cost should be zero if there is ample water. It is important to realise that ample water refers not so much to high seasonal flows, but to the continuous base flow. A high proportion of household demand as well as irrigation is supplied directly from rivers and streams and not from large water storage facilities. Accordingly it is not only the volume of water that plays a role, but the fact whether the supply is continuous throughout the year. In principle this should be the case for Southern KwaZulu-Natal and the northern portions of the former Transkei.

8.1.3 Environmental cost of water development

The inclusion of the impact on the environment in CBA was highlighted by the publication of the Pearce Report, commissioned by the Secretary of State for the Environment in the United Kingdom (UK) government. A result thereof is that the UK government recommended that environmental impacts must be brought into formal appraisal procedures wherever possible.

In the raw water pricing strategy the ecological sustainability is also highlighted as one of the main objectives of the pricing strategy.

In Table 22 a checklist is provided which should assist the CBA researcher to identify the positive and negative impacts that water development could have on the environment.

Table 22: Environmental Aspects Related to Water Development

Ecosystem Goods and Services	Ecosystem Functions	Examples
Gas regulation	Regulation for chemical composition of the atmosphere	Carbon sequestration, oxygen and ozone production
Climate regulation	Regulation of temperatures, precipitation at local levels	Urban heat amelioration, wind generation
Disturbance regulation	Regulation of episodic and large environmental fluctuations on ecosystem functioning	Flood control, drought recovery, refuges from pollution events
Water supply and regulation	Supply and regulation of water flow	Provision of water for agricultural, industrial and household use
Sediment supply and regulation	Regulation of sediment supply to estuary and marine environment	Maintenance of beaches, sand-bars, sand banks
Erosion control	Retention of soil within an ecosystem	Prevention of soil loss by vegetation cover, and by capturing soil in wetlands
Soil formation	Soil formation processes	Weathering of rock by water and accumulation of organic material in wetlands
Nutrient cycling	Storage, recycling, capture and processing of nutrients	Nitrogen fixation, nitrogen cycling through food chains
Waste treatment	Recovery of nutrients, removal and breakdown of excess nutrients	Breaking down of waste, detoxifying pollution
Biological control	Regulation of animal and plant populations	Predator control of prey species, maintain population balance
Refugia	Habitat for resident and migratory populations	Nurseries, habitat for migratory fish and birds, regional habitats for species
Food production	Primary production for food	Production of fish and plants
Raw materials	Primary production for raw materials	Production of craftwork materials, house building materials and fodder
Genetic resources / Natural products	Unique biological materials and products	Genes for food and ornamental fish species, plant fibres
Nature appreciation	Providing opportunities for the appreciation of natural features and wildlife	Providing access to features and wildlife for viewing and walking
Recreation and fishing	Provision of opportunities for sport in or on water, and for sport fishing	Swimming, sailing, canoeing, skiing, fly-fishing and conventional fishing
Transport	Provision of opportunities for water-based transport	Harbours, ferries, ski-boat launching
Archaeological/historical/cultural	Providing opportunities for non-commercial use	Aesthetic, educational, spiritual, intrinsic and scientific values of ecosystems
Scenery	Provision of scenic views	Residential houses, flats and offices with scenic views

Source: Miles Mander, Institute of Natural Resources, Pietermaritzburg.

For the purpose of CBA, the economic value of environmental goods is measured mainly through the concepts of willingness to pay (WTP) and willingness to accept (WTA) compensation.

Four methods are mainly used in the valuating of environmental goods (Hanley and Spash 1993), namely:

i) Contingent valuation method (CVM) (Hanley and Spash) [50]

"CVM works by directly soliciting from a sample of consumers, their WTP and/or WTA for a change in the level of environmental service flows, in a carefully structured hypothetical market."

ii) Hedonic Pricing Method (HP) (Hanley and Spash) [51]

"The method identifies environmental service flows as elements of a vector of characteristics describing a marketed good, typically housing. HP seeks to find a relationship between the levels of environmental services (such as noise levels or total suspended particulate levels), and the prices of the marketed goods (houses). HP has been used to value such things as noise levels around airports, earthquake risks and urban air quality."

iii) Travel Cost Method (TCM) (Hanley and Spash) [52]

"The travel cost method seeks to place a value on non-market environmental goods by using consumption behaviour in related markets. Specifically, the costs of consuming the services of the environmental asset are used as a proxy for price. These consumption costs will include travel costs, entry fees, on-site expenditures and outlay on capital equipment necessary for consumption."

iv) Production Function Approaches (Hanley and Spash) [53]

Production function approaches "link environmental quality changes to changes in production relationships. When a change in environmental quality occurs, households are able to react. In the case of decreasing quality, expenditures will be made to mitigate the effects and protect the household from welfare reductions. An example is an increase in aircraft noise due to a new airport. In the absence of intervention households will engage in averting behaviour, such as moving away from the area (an impact measurable via hedonic pricing) or noise-proofing their home."

8.2 Methodology to Calculate Economic Value of Water

The objective of this section is to give some guidelines to determine the economic value of water for different categories of water users.

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50 **Hanley, N. and Spash, C.L. 1993. *Cost-benefit analysis and the environment.* Edward Edgar, Vermont, p. 53.**

51 **Hanley, N. and Spash, C.L. Ibid p. 74.**

52 **Hanley, N. and Spash, C.L. Ibid p. 83.**

53 **Hanley, N. and Spash, C.L. Ibid pp 98-99.**

The value of water is loosely defined as the maximum amount the user would be willing to pay for the use of an amount of water. In the absence of market clearing prices, there are a number of alternate means of estimating the value. (See Gibbons (1986) [54]). First, there may be some evidence of market-like transactions within a given sector. Payments of this level for water indicate that the user is willing to pay at least a certain amount, which points to a lower limit put on the value for water in that sector.

More complete demand information may be required for a formal demand curve for a particular use thereof. If enough tariff and quantity data are available, a consumer or producer water demand curve can be estimated, from which, in turn, estimates can be made of marginal values/benefits of the resource use at different levels of demand.

Financial budget information on a single productive process can also be used to impute a share of total product value to the water input. If all factors of production are remunerated i.t.o. their marginal returns, the residual, after subtraction of all other intermediate inputs, is assumed to be the maximum economic value of the water input.

Without actually studying demand relationships, the concept of alternate cost can also be used to determine the economic value of water. The cost of the least expensive alternative to water serves as a proxy for the maximum amount the user might be willing to pay for water.

8.2.1 Urban households

The first step in the calculation of the economic value of water is to derive a price demand function based on consumer demand and from that price elasticities can be calculated. This price demand function can be calculated for urban households in total or for various income groups. It could even be further broken down and calculated, for example for indoor and outdoor use.

Methods available in this regard are the following:

[54] **Gibbons, D.C., 1986, "The Economic Value of Water", A Study from Resources for the Future, Washington DC, the Johns Hopkins University Press.**

- **Contingent Valuation**

Information is obtained by means of questionnaires. The first step is to establish a typical user profile. After this, the effect that a price increase would have on these consumption patterns is determined.

A shortcoming of this method is that outcomes are not actually observed, but are based on expectations.

This method was used by Veck and Bill (1998)[55] to determine the price elasticity of demand for water.

- **Time Series Analysis**

Here tariff and demand quantity data are compared over time (at least 15 observations) in order to determine a relationship between them.

A shortcoming in terms of South Africa is that there is very little variance of the tariff structure in the past. During periods of drought, when the tariff was used to regulate volumes of water, it was done mostly in conjunction with direct control measures.

- **Cross Sectional Analysis**

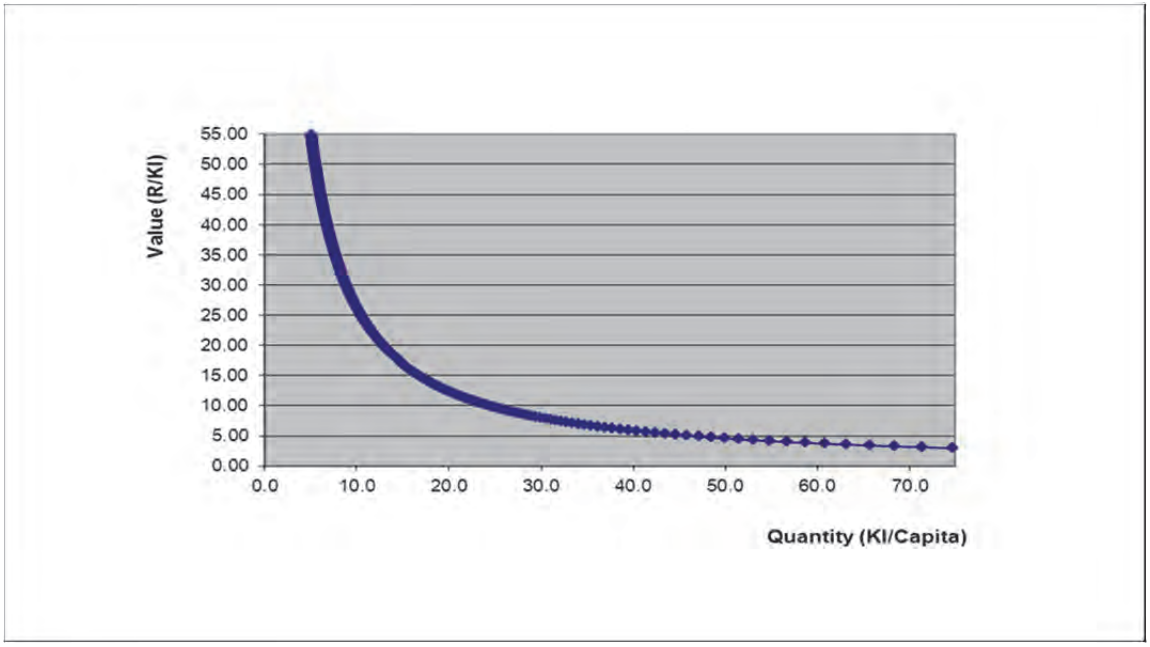
The reaction of different water users to tariff levels at the same point in time is investigated. An example of this is where a relationship is being determined between consumption and tariff data for different municipalities. An advantage of this method is that many factors influencing water consumption can be simultaneously analysed through multi-regression analysis.

8.2.1.1 Calculation of economic value

For CBA purposes it is important to calculate the value of the total amount of water consumed by a specific urban household category. This can be derived from the demand schedules referred to above. Graph 2 is an example of the price demand schedule for the category: Urban households: High income: Outdoor[56].

[55] **Veck, A, and Bill, M., 2000, Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach. Report 790/1/00. Water Research Commission.**
[56] **This is only a hypothetical case and the figures do not have any practical application.**

Graph 2: Demand Curve: Households: High Income: Outdoor



In probably most of the cases the CBA analyst will not estimate the tariff demand schedule her/himself but will make use of secondary information. To construct a price demand schedule for her/his specific project (s)he needs the current tariff as well as the average consumption of the category of households for a specific period (per month). Further (s) he also needs the price elasticity for that specific category.

The demand curve is constructed by assuming that the value of the last unit of water consumed is equal to the tariff paid by the consumer.

The highest quantity lowest value represents the current tariff. In the case of the example in Graph 2 this equals R4.28 which represents a CPI adjusted figure to reflect 2012 prices.

The economic value of water (per capita per annum) can be defined as the total area under the curve. The value can be derived by calculating the integral under the price demand curve. To obtain the value per cubic metre of water, the total value should be divided by the volume of water use. In regard to this graph, the quantity of water consumed totals 60 kilolitre per capita per annum.

8.2.2 Rural households

8.2.2.1 Introduction

It is very difficult to assign an economic value to household water use in general and more particular to use by rural households.

Water is a good that has a value when it is consumed. However, if water is not available or unsuitable for human consumption it has wider implications for the wider society. In theory, the benefits of private goods are fully divisible and excludable, and the benefits of public goods are indivisible and non-excludable. Industrial water is a private good, but household water can provide broader health benefits and is therefore neither a purely private nor public good. On the spectrum of private to public goods, household water lies between the two extremes, probably closer to pure private goods. Although this argument applies with regard to urban household water, rural household water could probably be viewed as closer to a public good. This is also in line with current government policy where a certain amount of water is supplied free to the poor.

Public or collective benefits are generally considered difficult to quantify and are intangible. The current practice in South Africa[57] and also by the World Bank[58] is to make use of the willingness to pay concept to calculate the economic value of water use by households in developing areas. By definition, this means that rural water is regarded as a private good. However, it will be recognised from the methodology that the pure willingness to pay principle in the true sense, is only partially applied.

8.2.2.2 Methodology

The economic value of water is determined in two components. The first component deals with the social (public) portion of 25 litres of water per capita/per day. This portion is in accordance with the government's policy on minimum water requirements for urban and rural households.

The second component deals with the volume of water consumed above the 25 litres per capita/per day. This water is regarded as a pure private good.

- **Social Portion of Water Consumption**

The DBSA currently uses the following percentages for the social portion of water consumption for households of a household income as the amount presenting the willingness to pay of that household to pay for the social portion of the water.

	Potable Water	Sanitation
Low Income	4,0%	3%
Medium Income	2.7%	2,0%
High Income	1,3%	1,0%

[57] **Internal Documentation of DBSA.**
[58] **World Bank. Operations Evaluation Department. May 1997. Report no. 146.**

The following illustrates the methodology to calculate the economic value for the social portion per kl for the low income households in a specific rural area: is as follows:

Economic value of water = 4 % of actual household income
monthly water consumption per household

= R75/month/household
4, 56 kl/month/household

= R16.42 per kl

Where:

The monthly income of a rural household consisting of six persons is R 1875. This is the average wage for unskilled labour in rural areas for all provinces. See Table 12.

And:

Monthly Water Consumption per household = 25 litres per capita per day
x 6 persons x 30, 44 days
= 4,565.63 kl per month

- **Private Portion of Water Consumption**

The economic value of the balance of consumption is estimated by using the current tariff for water and also taking into account the surplus value of that water. This is done by using the average of the current tariff per kl and the economic value of the social component, per kl as calculated above.

An example of this methodology for calculating the economic value of the private portion of water consumption is as follows:

$$\text{Economic value of water per kl} = \frac{\text{Value Social portion in R/kl + current tariff in R/kl}}{2}$$

$$= \frac{\text{R9.65 + R26.38}}{2}$$

$$= \text{R18.02}$$

Consequently the economic value for water is as follows:

Economic Value:	Social portion	=	R16.42 per kl
Private portion=	R18.02 per kl		

The total value of water for a specific rural area is the weighted economic value of the social and private portion. An example of this for a household consuming 15 kl per month is as follows:

4565.63 kl x R16.42/kl	=	R 75.15
10 431.25 kl x R18.02/kl	=	R 187.92
Total monthly value		R263.07
Value per kl	=	R263.07/15 kl
	=	R17.54/kl

8.2.3 Irrigation agriculture[59]

The basic methodologies for estimating water values are crop-water production function analysis and farm crop budget analysis (including linear programming).

8.2.3.1 Crop – water production function analysis

The relationship between inputs and outputs of crop production can be expressed mathematically as the crop production function. If all other inputs are held constant, the marginal physical productivity of water for each unit of water used on the crop can be calculated. The marginal value of each unit of water is the marginal physical product times the crop price. This procedure relies on the assumption that applications of different amounts of water incur the same labour, fertilizer, and other non-water input costs. Since these marginal values are not dependent on the economics of crop production, they are not related to fixed or variable costs, but only to the crop selling price and the physical productivity of the water unit. In addition, they reflect the value of on-site irrigation water.

Although the theory underpinning the crop-water production function method is sound, it is not used often to calculate the economic value of irrigation water. In most places and for most crops, the actual physical productivity of water is not known. Crop-water production functions have not been scientifically established and the share of yield contributed by the water input has not been determined.

8.2.3.2 Farm crop budget analysis

A more popular method of estimating the economic value of irrigation agriculture is farm crop budget analysis. It is calculated as the total crop revenue less non-water input costs. This residual can be defined as the maximum amount the farmer could pay for water and still cover costs of production. It thus represents the on-site value of water. If water procurement costs are further subtracted, the net value for irrigation is then comparable to in stream water values. This monetary value divided by the total quantity of water used on the crop,

[59] **The theory regarding valuation methods of water is taken from Gibbons Diana C (1985).**

determines a maximum average value, or willingness to pay, for water for that crop. Depending on whether or not fixed costs are included, such values can be short-run or long-run average values.

8.2.3.2.1 Linear Programming (LP) Analysis

For calculating the economic value of a single crop the method explained above is sufficient. However, it is accepted that a farm consists of more than one crop option and switching can take place between products as the supply of water increase or decrease. In instances like this, more sophisticated methods to calculate the economic value of water with regard to irrigation agriculture will have to be applied. Probably the most important one is Linear Programming (LP) Analysis. For the calculation of irrigation water values, the LP objective is to maximise net returns for a farm of specified hectares subject to constraints which may be economic or physical, such as hectares limitations for each crop, input cost per unit, available technology, constant water requirements set for each crop, crop prices, and so forth. In the LP solution, limiting the hectares of certain risky crops is one way to incorporate the desired level of risk to the farmer.

LP analysis can also be used to estimate marginal values for irrigation water on a representative farm, but not by crop. Instead of water cost, water supply is varied and an LP solution is found for each quantity of water available to the farm, all other constraints remaining constant. When the supply of water is low, the programme solution allocates water to its highest-valued uses, but as supply increases other less valuable or more water-intensive crops are added, and the marginal value of additional units of water falls. The set of shadow prices derived at various levels of water supply forms a water demand schedule for the farm.

8.2.4 Electricity

The economic value of hydropower is frequently recognised all over the world. However, in the case of South Africa, coal based power stations generate most of the electricity consumed in the country.

In this section specific attention will be given to the development of a demand curve for coal based power stations. From this the economic value of water used for electricity generation by coal based power stations, can be deduced[60] .

The main aim of the methodology is followed to calculate the economic value of water used in coal based power stations is to minimise the cost of water utilised in the process[61].

Two cooling systems are used in these South African power stations, namely wet and dry cooling systems. A wet cooling system uses much more water than a dry cooling system in order to generate the same amount of electricity. In a wet

[60] For calculation of the economic value of water for electricity generation by hydropower stations (See Gibbons Ibid, p. 86).

[61] A similar approach is also discussed in Gibbons Ibid p. 50.

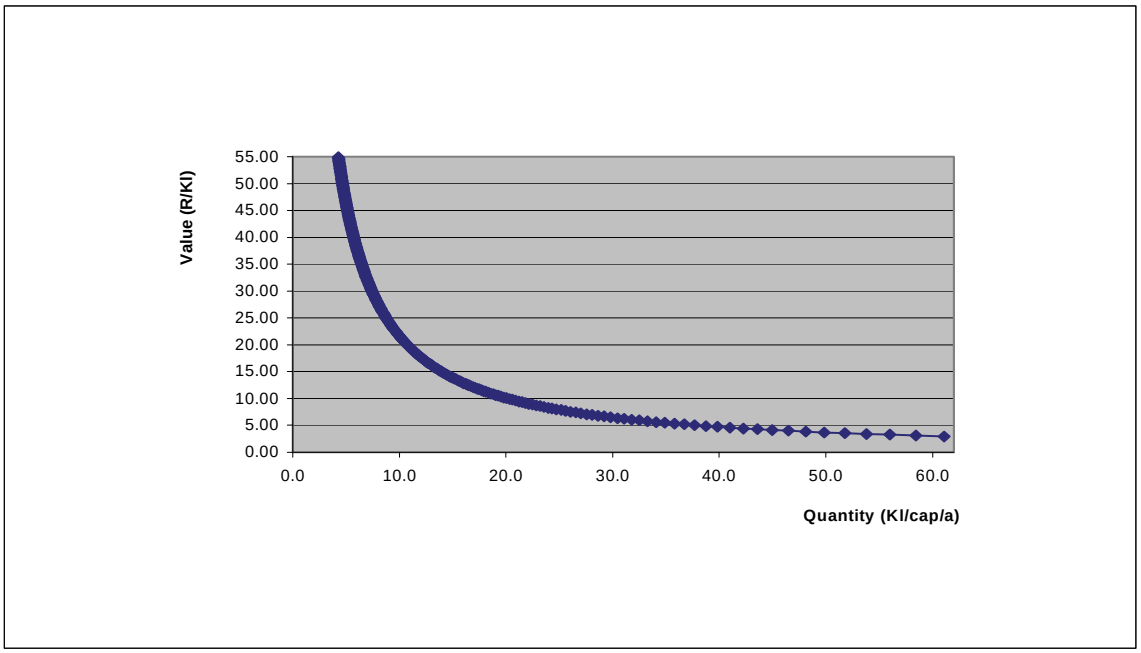
cooling system 2.23l of water is used to generate 1kWh of electricity compared with the 0.22l of water per kWh of electricity in a dry cooled system.

On the negative side it must be stated that building a dry cooling system is much more costly than a wet one. The running costs are also slightly higher. It is also difficult and very costly to convert a power station from a wet to a dry cooling system. The demand schedule for water is therefore very inelastic.

In a CBA study done by Conningarth Consultants for the WRC in 1999[62] on dry cooling, it was established that at a water tariff of R3, 90 per kl the dry cooling process becomes the cheaper of the two processes. This figure was updated with a CPI index to R5.65 per kl to reflect 2012 prices.

If the above information is taken into consideration it is possible to construct a demand curve as indicated in Graph 3 below.

Graph 3: Demand Curve of Water Use: Electricity



In practice one must however, accept that not all power stations will immediately change over to the dry cooling process. Factors like the age of the power station, water tariff and other financial factors will play a role.

A more smoothed demand curve than the one depicted in Graph 2 is probably more applicable when showing the real situation.

[62] **Conningarth Consultants Evaluating the Impact of Selected Water Research Commission Projects – A Cost Benefit Analysis – A CBA Approach, 2000.**

8.2.5 Industry

With regard to the economic value of water used in industrial processes, it is notable that the cost of water is only a small percentage of the total cost of production. Even for industries that use huge quantities of water, the cost of water will be dwarfed by other production inputs, such as labour, energy, capital and raw materials utilised.

It is thus clear that decisions on locality, technologies used, and scale of operations to maximise profits are more important than that of effective water utilization.

Theoretically the demand and value of water used in industries could be derived from statistical industrial production functions or using the residual imputation method. However, in view of the importance of water (quantity) these methods are not used very often. Instead the economical value of water for industrial usage has been calculated by using the so-called second best cost alternative (that is the cost to recirculate water within the production process). That means that industry will normally only be willing to pay for new water supply equal to the cost to produce water of adequate quantity through treatment and reuse[63].

Currently the residual imputation method, also known as the budget approach, is applied in a study to analyse various industries in South Africa in order to derive a demand curve for industrial water. This was also used by Urban-Econ[64].

8.3 Computer Program for Conversion Factor for Assets

A computerised model has been developed, whereby a weighted shadow price of various inputs used in the production of capital assets can be calculated. The assets that are included in the model are various water augmentation assets, typical assets found in a SAM specifically the South African SAM and various other important assets. The output of the model is given in Table 23. The model is also available in electronic format on the CD enclosed. It should be noted that the figure is only given for illustrative purpose. When using the model the shadow price adjustment factors for each input need to be adjusted according to the appropriate tables in the manual. For example the factor used for unskilled labour is the wage factor for non-urban unskilled labour in the Western Cape. Thus if the project in question is taking place in an urban area in the Eastern Cape, the factor needs to be adjusted in accordance with Table 12(a) in the manual. Space has been left in the model for the user to insert additional assets. If this is done coefficients for the inputs used in the production of that asset need to be calculated and placed in the model. Additional inputs can also be incorporated into the model for each of the assets listed. Once the relevant coefficients are entered into the model, it will run automatically. In the case of additional inputs, shadow price factors will have to be inserted into the model over and above the coefficients.

[63] See Gibbons, Ibid, for more explanations.
[64] Urban-Econ. The determination of Economic Value of Water for the Vaal River System Area. A report by Urban-Econ for Department of Water Affairs. PC 000/00/10291. May 1991.

The model has been extended to include the operational sectors contained in the South African SAM. These sectors are not included in the output displayed in Table 23; however, they are available electronically.

Table 23: Conversion Factors

Development of Conversion Factors for Assets												
CONVERSION FACTORS												
RELATIVE IMPORTANCE OF INPUTS WHERE	DIESEL	PETROL	PETROLEUM PRODUCTS	ELECTRICITY	UNSKILLED	(EXCHANGE RATE)	CUSTOMS	Other 1	Other 2	Other 3	Other 4	WEIGHTED SHADOW
SHADOW PRICES ARE APPLICABLE			(includes petrol and diesel)		LABOUR		DUTY					PRICE FACTOR
A. ASSETS CONTAINED IN THE SOUTH AFRICAN SOCIAL ACCOUNTING MATRIX												
1. Furniture	0.000	0.000	0.005	0.007	0.001	0.569	0.569	0.000	0.000	0.000	0.000	1.099
2. Rubber products	0.000	0.000	0.062	0.022	0.016	0.426	0.426	0.000	0.000	0.000	0.000	1.064
3. Structural Metal Products	0.000	0.000	0.005	0.002	0.015	0.475	0.475	0.000	0.000	0.000	0.000	1.077
4. Other Fabricated metal products	0.000	0.000	0.020	0.014	0.015	0.190	0.190	0.000	0.000	0.000	0.000	1.029
5. Machinery and equipment	0.000	0.000	0.021	0.005	0.010	0.668	0.668	0.000	0.000	0.000	0.000	1.109
6. Electrical machinery and apparatus	0.000	0.000	0.022	0.004	0.010	0.458	0.458	0.000	0.000	0.000	0.000	1.073
7. Manufacturing of transport equipment	0.000	0.000	0.005	0.001	0.007	0.844	0.844	0.000	0.000	0.000	0.000	1.142

8. Other manufacturing and recycling	0.000	0.000	0.005	0.003	0.011	0.279	0.279	0.000	0.000	0.000	0.000	1.045
9. Buildings	0.000	0.000	0.023	0.001	0.016	0.136	0.136	0.000	0.000	0.000	0.000	1.014
10. Civil Construction	0.000	0.000	0.048	0.002	0.020	0.138	0.138	0.000	0.000	0.000	0.000	1.009
11. Business activities (architects, attorneys, etc.)	0.000	0.000	0.025	0.001	0.011	0.10	0.10	0.000	0.000	0.000	0.000	1.009
B. WATER AUGMENTATION COMPONENTS												
12. Bulk water (dams)	0.120	0.060	0.000	0.020	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.934
13. Reservoirs	0.030	0.000	0.000	0.000	0.170	0.070	0.070	0.000	0.000	0.000	0.000	0.956
14. Pump stations (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.100	0.100	0.000	0.000	0.000	0.000	0.961
15. Bulk pipelines (water & sewer)	0.070	0.000	0.000	0.000	0.170	0.170	0.170	0.000	0.000	0.000	0.000	0.964
16. Treatment works (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.070	0.070	0.000	0.000	0.000	0.000	0.956
17. Reticulation (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.100	0.100	0.000	0.000	0.000	0.000	0.961
18. Storm water	0.100	0.050	0.000	0.010	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.936
C. Other Assets												
19. Roads	0.210	0.120	0.000	0.000	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.902
20. Parks and Recreation	0.210	0.120	0.000	0.000	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.902
21. Schools, Crèches, etc.	0.080	0.020	0.000	0.050	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.956
D. Costs Associated with Construction												
22. Maintenance and operation	0.160	0.090	0.000	0.020	0.170	0.000	0.000	0.000	0.000	0.000	0.000	0.909
23. Earth works	0.000	0.000	0.111	0.000	0.102	0.065	0.065	0.000	0.000	0.000	0.000	0.959

24. Research and development	0.000	0.000	0.007	0.018	0.017	0.022	0.022	0.000	0.000	0.000	0.000	1.004
25. Relocation costs	0.000	0.000	0.009	0.000	0.044	0.062	0.062	0.000	0.000	0.000	0.000	0.996
26. Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
27 Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
28. Other 3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
29. Other 4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
Shadow Price Adjustment Factor	0.791	0.844	0.804	1.337	0.704	1.222	0.950	1.000	1.000	1.000	1.000	
Note: 1. Customs duty (shadow price adjustment factor) is already adjusted to take into account the direct import content of the plant.												
2. The shadow price adjustment factor used for unskilled labour is the factor for non-urban unskilled labour in the Western Cape. This factor needs to be adjusted according to the location of the project in question using table 6.1a												

CHAPTER 9: PRACTICAL EXAMPLES

9.1 Introduction

In this chapter a few basic and practical examples are of CBA applications that were done in South Africa. The project description of each example is given. However, the detailed examples appear on a CD provided in the back cover of this report. The enclosed CD will allow a researcher to follow the methodology used in a detailed step by step approach.

The set of examples are:

1. Water Resource Development
2. Development of Potable Water
3. Industrial Project
4. Hydropower
5. Mining

9.2 Example 1: Water Resource Development

1 OBJECTIVE

The objective of Example 1: Water Resource Development is to evaluate the feasibility of a project to construct a dam. It is envisaged that the water will be used to supply raw water to a nearby Municipality, 6 new coal mine development and to a game farm. The dam will also be used for sailing, while a camping site will also be developed on the shores of the dam.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 31 years.

The example makes provision for:

- Consumption for household users
- The ecological and tourism benefits of the dam
- The use of water for mining activities
- Financial and economic analysis
- Various capital costs items
- Increases in number of connections and individual consumption over time
- Operational and maintenance costs

3 LAYOUT OF EXAMPLE

- Separate input and results sheet
- Financial analysis sheet
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  - Dam
  - Reservoir
  - Bulk Pipelines
  - Vehicles
  - Professional Fees
  - Contingencies
  - Escalation
- Operating & maintenance cost of the dam – R/Kl
- Operating & maintenance cost associated with delivery of the water into a raw water reservoir – R/Kl

5 PROJECT BENEFITS

- Revenue from water sales to consumers and to the mine
- Revenue from tourism

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)

(Definition of BCR: NPV of total benefits divided by NPV of total costs)

7 ECONOMIC VALUE OF WATER

- The willingness to pay (WTP) for water was used for consumers
- For mines the value of water in the mining of coal was calculated.
- The ecological and economic benefits of tourism were calculated and include;
  - Cultivated Floodplains
  - Provision of Stock Water
  - Recreational Fishing, Boating and Camping
  - Contribution of the water to the consumer surplus of the game farms

9.3 Example 2: Potable Water

1 OBJECTIVE

The objective of Example 2: Potable Water is to evaluate the feasibility of a community project with regard to the delivery of potable water. This is as a result of a community that had to be resettled due to the construction of a new dam for irrigation purposes. Raw water is purchased from dam operator and then purified.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 20 years.

The example makes provision for:

- Consumption for household and commercial users
- Different income-levels
- Differentiated tariff structure
- Financial and economic analysis
- Various capital cost items
- Increases in number of connections and individual consumption over time.
- Operational and maintenance costs
- Model determines shadow prices for capital and operational elements interactively.

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Financial analysis sheet
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  - Reservoirs
  - Treatment Works
  - Pump Stations
  - Bulk Pipelines
  - Telemetry
  - Reticulation
  - Computers
  - Vehicles

- Contingencies
- Professional Fees
- Other Capital Expenditure
- Annual Escalation

- Purchase of raw water from the bulk supplier - R/Kl
- Operating & maintenance cost of water purification – R / Kl
- Operating & maintenance cost of reticulation (including administration costs) - R/Kl
- Connection costs

5 PROJECT BENEFITS

- Revenue from water sales
- Reduction in water losses
- Savings in operation & maintenance costs, if any

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)

(Definition of BCR: NPV of total benefits divided by NPV of total costs)

9.4 Example 3: Industrial Project

1 OBJECTIVE

The objective of Example 3: Industrial project is to evaluate the feasibility of a community project with regard to the construction and operation of a small gin factory to produce cotton yarn and waste. It is envisaged that the raw cotton will be sourced from local farmers.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 10 years.

The example makes provision for:

- The sale of production
- Operating and administration costs
- Financial and economic analysis
- Various capital cost items

- Model determines shadow prices for capital and operational elements interactively

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Financial analysis (in real prices) sheet
- Economic analysis (in nominal prices sheet)
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  - Land costs
  - Construction costs
  - Equipment costs
  - Professional fees
  - Contingencies
  - Finance costs during construction
- The sale of cotton yarn and cotton waste
- Operating and Maintenance Costs
  - Cost of goods sold
  - Administration and General Costs
  - Selling Costs

5 PROJECT BENEFITS

- Revenue from water sales
- Reduction in water losses
- Savings in operation and maintenance costs, if any

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)

(Definition of BCR: NPV of total benefits divided by NPV of total costs)

9.5 Example 4: Hydro-Electricity Model

1 OBJECTIVE

The main objective of a CBA of this nature is to evaluate the merit of using hydro-electricity for developmental goals. The emphasis in respect of the economic impacts of electricity generation is more on how the sales thereof to potential markets will benefit end-users.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 40 years.

The example makes provision for:

- CO2 emission for coal fired steam plant per 1000 GWh (million tons of CO2)
- CO2 emission for coal fired combined cycle plant per 1000 GWh (million tons of CO2)
- CO2 emission for average thermal plant per 1000 GWh (million tons of CO2)
- Value of CO2/Ton (R)
- Percentage distribution between markets
- Quantity (GWh p.a)
- Price of second best generating alternative (R/MWh)
- Distance from transmission lines to market (Km)
- Transmission costs (MWh/km)
- Infrastructure costs
- Operational and maintenance costs

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Modelling preparation
- Detailed modelling System

4 PROJECT COST

- Capital Cost:
  - Hydro electricity
  - Water Resources
- Operating & maintenance cost of water resources – Calculated as a percentage of capital costs.

- Operating & maintenance cost of Hydro-Electricity – Calculated as a percentage of capital costs.
-

5 PROJECT BENEFITS

- Revenue from electricity sales
- Benefits from reduced CO2 emissions

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit-Cost ratio (BCR)

9.6 Example 5: Coal Mining

1 OBJECTIVE

The objective of Example 3: Industrial project is to evaluate the feasibility of a coal mining project.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 20 years.

The example makes provision for:

- Coal production tons
- Domestic and export saleable tons
- Domestic and export prices for coal
- Various capital cost items
- Operational and maintenance costs
- Shadow prices for capital and operational elements

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Capital and operating costs sheets
- Revenue sheets
- Financial analysis sheet
-
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  - Total Mine Colliery
  - Rail Transport Infrastructure
  - Water Supply Infrastructure
- Operating and maintenance cost of total mine colliery
- Operating and maintenance cost of rail infrastructure
- Operating and maintenance cost of water infrastructure
- Externalities and rehabilitation
- Transport costs
- Water supply costs
  -

5 PROJECT BENEFITS

- Revenue from domestic sales
- Revenue from export sales
-

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)

(Definition of BCR: NPV of total benefits divided by NPV of total costs)

ANNEXURE 1: REVISED MAGISTERIAL DISTRICTS PER FUEL PRICE ZONE

MAGISTERIAL DISTRICT	PRICE ZONE
Aberdeen	9B
Adelaide	5A
Albany	4A
Albert (Burgersdorp)	7A
Alberton	9C
Alexandria	4A
Alfred	5A
Aliwal North	7A
Amersfoort	8C
Babanango	6A
Bafokeng	10C
Balfour	8C
Barberton	10C
Barkly East	8A
Barkly West	11C
Bathurst	5A
Beaufort West	8B
Bedford	5A
Belfast	9C
Belville	1A
Benoni	9C
Bergville	6C
Bethal	8C
Bethlehem	7C
Bethulie	8A

MAGISTERIAL DISTRICT	PRICE ZONE
Bizana	7B
Bloemfontein	10C
Bloemhof	10C
Bochum	13C
Boksburg	9C
Bolobedu	13C
Boshof	10C
Bothaville	9C
Botshabelo	10C
Brakpan	9C
Brandfort	10C
Bredasdorp	6A
Brits	10C
Britstown	9A
Bronkhorstspruit	9C
Bultfontein	10C
Cacadu (Glen Grey)	6A
Caledon	5A
Calitzdorp	4A
Calvinia (west of 20° longitude)	12B
Calvinia (east of 20° longitude)	14B
Camperdown	2A
Cape Town	1A
Carnarvon	10B
Carolina	9C

MAGISTERIAL DISTRICT	PRICE ZONE
Cathcart	5A
Ceres	5A
Chatsworth	1A
Christiana	10C
Clanwilliam	7B
Clocolan	8C
Cofimvaba	5A
Colesberg	8A
Coligny	10C
Cradock	8B
Cullinan	9C
Dannhauser	6C
De Aar	8A
Delareyville	11C
Delmas	9C
Dewetsdorp	10C
Ditsobotla	12C
Dundee	6C
Durban	1A
Dzanani Central	13C
Dzanani North	14C
Dzanani South	13C
East London	1A
Edenburg	8A
Eerstehoek	9C

MAGISTERIAL DISTRICT	PRICE ZONE
Elliot	8A
Ellisras	13C
Embumbulu	2A
Engcobo	7A
Ermelo	8C
Eshowe	4A
Estcourt	5C
Excelsior	9C
Fauresmith	9A
Ficksburg	8C
Fort Beaufort	5A
Fouriesburg	7C
Frankfort	8C
Fraserburg	8B
Ganyesa	15C
Gatyana	5A
Gcuwa (Butterworth)	5A
George	3A
Germiston	9C
Giyani	14C
Glencoe	6C
Goodwood	1A
Gordonia (south of 28° latitude)	13A
Gordonia (between 27°30' and 28° latitude)	17A
Gordonia (north of 27°30' latitude)	19A

MAGISTERIAL DISTRICT	PRICE ZONE
Graaf-Reinet	9B
Groblersdal	10C
Hankey	3A
Hanover	8A
Harrismith	6C
Hartswater	11C
Hay	11A
Heidelberg (Cape)	4A
Heidelberg (Tvl.)	9C
Heilbron	8C
Hennenman	8C
Herbert	10C
Hermanus	5A
Herschel	8A
Hewu	5A
Highveld Ridge	8C
Hlabisa	5A
Hofmeyr	7A
Hoopstad	10C
Hopefield	5A
Hopetown	9A
Humansdorp	3B
Idutywa	5A
Impendle	5C
Inanda	1A

MAGISTERIAL DISTRICT	PRICE ZONE
Indwe	7A
Ingwavuma	7A
Ixopo	4A
Jacobsdal	10C
Jagersfontein	8A
Jansenville	7B
Johannesburg	9C
Joubertina	7B
Kamhlushwa	10C
Keiskammahoek	4A
Kempton Park	9C
Kenhardt (east of 20° longitude)	15A
Kenhardt (west of 20° longitude)	19A
Kentane	5A
Kimberley	11C
King William's Town	3A
Kirkwood	3A
Klerksdorp	9C
Kliprivier	5C
Knysna	4A
Koffiefontein	9A
Komga	3A
Koppies	8C
Koster	10C
Kranskop	5A

MAGISTERIAL DISTRICT	PRICE ZONE
Kriel	8C
Kroonstad	8C
Krugersdorp	9C
Kudumane	15C
Kuils River	1A
Kuruman (south of 27° latitude)	13C
Kuruman (north of 27° latitude)	17C
Kwabhaca (Mount Frere)	10B
KwaMhlanga	10C
Ladismith (Cape)	6B
Lady Grey	8A
Ladybrand	8C
Lahurushe	11C
Laingsburg	7B
Letaba	13C
Lichtenburg	11C
Lindley	8C
Lions River	4C
Lower Tugela	3A
Lower Umfolozi	5A
Lusikisiki	10B
Lydenburg	10C
Maclear	8A
Madikwe	11C
Mahlabatini	6A

MAGISTERIAL DISTRICT	PRICE ZONE
Malamulele	14C
Malmesbury	3A
Malmesbury (south of 33°30' latitude)	1A
Maluki (Matatiële)	7A
Mankwe	10C
Mapulaneng	11C
Mapumulo	3A
Marico	11C
Marquard	8C
Maxesibeni (Mount Ayliff)	8B
Mbibana	10C
Mdutjana (Siyabuswa)	10C
Messina (east of 30° longitude)	14C
Messina (west of 30° longitude)	16C
Mdantsane	1A
Mhala	11C
Middelburg (Cape)	7A
Middelburg (Tvl.)	10C
Middledrift	4A
Mitchells Plain	1A
Mkobola	10C
Moanduli	7A
Mokerong 1	16C
Mokerong 2	11C
Mokerong 3	11C
Molopo	11C

MAGISTERIAL DISTRICT	PRICE ZONE
Molteno	6A
Montagu	5A
Mooi River	5C
Moorreesburg	4A
Moretele 1	9C
Moretele 2	9C
Mossel Bay	1A
Mount Currie	7A
Mount Fletcher	10B
Moutse	10C
Mpofu (Stockenström)	5A
Msinga	5C
Mtonjaneni	5A
Mtunzini	4A
Murraysburg	12B
Mutale	14C
Namakgale	12C
Namakwaland (south of 30° latitude)	31J
Namakwaland (between 29°-30° lat. & 17°30'-18°30' long.)	32J
Namakwaland (north of 30° lat. & east of 18°30' long.)	33J
Namakwaland (north of 29° lat. & east of 17° long.)	34J
Namakwaland (south of 29° lat. & west of 17° long.)	35J
Namakwaland (between 29°-30° lat. & 17°-17°30' long.)	36J
Namakwaland (north of 29° lat. & west of 17° long.)	37J
Naphuno	12C

MAGISTERIAL DISTRICT	PRICE ZONE
Ndwedwe	2A
Nebo	11C
Nelspruit	10C
New Hanover	5C
Newcastle	6C
Ngotshe	7A
Ngqeleni	7A
Nigel	9C
Nkandla	5A
Nongoma	6A
Noupoort	7A
Nqamakwe	5A
Nqutu	6C
Nsikazi	10C
Oberholzer	9C
Odendaalsrus	9C
Odi	9C
Oudtshoorn	4A
Paarl	2A
Parys	9C
Paulpietersburg	7C
Pearston	8B
Peddie	4A
Petrusburg	10C

MAGISTERIAL DISTRICT	PRICE ZONE
Phalaborwa	12C
Philipstown	9A
Philippolis	8A
Piet Retief	8C
Pietermaritzburg	3C
Pietersburg (south of Tropic of Capricorn)	12C
Pietersburg (north of Tropic of Capricorn)	13C
Piketberg	6B
Pilgrim's Rest	11C
Pinetown	1A
Polela	5C
Port Elizabeth	1A
Port Shepstone	4A
Postmasburg	13C
Potchefstroom	9C
Potgietersrus (south of Tropic of Capricorn)	11C
Potgietersrus (north of Tropic of Capricorn)	16C
Pretoria	9C
Prieska	10A
Prince Albert	7B
Queenstown	5A
Qumbu	7A
Randburg	9C
Randfontein	9C
Reddersburg	8A

MAGISTERIAL DISTRICT	PRICE ZONE
Reitz	8C
Richmond (Cape)	8A
Richmond (Natal)	3A
Ritavi	13C
Riversdale	4A
Robertson	5A
Roodepoort	9C
Rouxville	8A
Rustenburg	10C
Sasolburg	9C
Schweizer-Reneke	11C
Sekgosese	13C
Sekhukhuneland	11C
Senekal	8C
Seshego	12C
Simon's Town	1A
Sipangeni (Flag Staff)	8B
Smithfield	8A
Somerset East	7B
Somerset West	2A
Soshanguve	9C
Soutpansberg (east of 29°30' longitude)	13C
Soutpansberg (west of 29°30' longitude)	16C
Springs	9C
Standerton	8C

MAGISTERIAL DISTRICT	PRICE ZONE
Stellenbosch	2A
Sterkstroom	5A
Steynsburg	7A
Steytlerville	7B
Stockenström	5A
Strand	2A
Stutterheim	4A
Sutherland	12B
Swartruggens	10C
Swellendam	5A
Tabankulu	10B
Tarka	5A
Taung	11C
Thabamoopo	12C
Thaba 'Nchu	10C
Thabazimbi (east of 27° longitude)	12C
Thabazimbi (west of 27° longitude)	13C
Theunissen	9C
Thohoyandou East	17C
Thohoyandou West	13C
Trompsburg	8A
Tsolo	7A
Tsomo	5A
Tulbagh	4A
Ubombo	7A

MAGISTERIAL DISTRICT	PRICE ZONE
Uitenhage	2A
Umlazi	1A
Umtata	6A
Umvoti	5C
Umzimkulu	5A
Umzimvubu	10B
Umzinto	3A
Underberg	5C
Uniondale	6B
Utrecht	7C
Vanderbijlpark	9C
Vanrhynsdorp	9B
Ventersburg	8C
Ventersdorp	10C
Venterstad	8A
Vereeniging	9C
Victoria East	4A
Victoria West	12B
Viljoenskroon	9C
Virginia	9C
Volksrust	7C
Vrede	8C
Vredefort	9C
Vredenburg	5A
Vredendal	9B
Vryburg (south of 26°30' latitude)	12C
Vryburg (east of 24° long. & north of 26°30' lat)	13C
Vryburg (west of 24° longitude)	17C

MAGISTERIAL DISTRICT	PRICE ZONE
Vryheid	6C
Vuwani	13C
Wakkerstroom	8C
Warm Baths	10C
Warrenton	11C
Waterberg	11C
Waterval Boven	9C
Weenen	5C
Welkom	9C
Wellington	2A
Wepener	8A
Wesselsbron	9C
Westonaria	9C
White River	10C
Williston	10B
Willowmore	7B
Winburg	9C
Witbank	9C
Witsieshoek	7C
Wodehouse	6A
Wolmaransstad	10C
Wonderboom	9C
Worcester	5A
Wynberg	1A
Xalanga	7A
Xhora (Elliotdale)	7A
Zastron	8A
Zwelitsha	3A

ANNEXURE 2: APPROACHES TO DETERMINE THE DISCOUNT RATE

The United States Environment Protection Agency (EPA) determines two major discounting approaches: intra-generational social discounting and inter-generational social discounting, depending on the impact of an investment over time.

Intra-generational Discounting
The intra-generational discounting is used when it comes to analyse a short and medium term project. Conventional intra-generational social discounting is rooted firmly in the view that the government is acting on behalf of its citizens in undertaking public projects and promulgating environment and other policies. Therefore, cost-benefit analysis of these actions should seek to estimate the costs and benefits experienced by all of the affected parties, and in so doing determine whether, in aggregate, the gainers under a policy would be able to compensate the losers.

This approach make use of an exponential discounting which is based on converting the future costs and benefits of a given investment into net present values using a constant discount rate[65].

Inter-generational Discounting
From the mid-1990s, with the growing concerns over environment problems caused by climate changes, global warming, and other environmental issues, there has been a renewed interest on how discounting should be applied to long-term projects, the effects of which spread over more than one generation or even hundreds of years, and whose present values are extremely sensitive to the choice of discount rate[66].

Unlike the intra-generational approach, inter-generational approach makes use of a hyperbolic discounting which makes use of a variable discount rate.

The next section describes in detail the two different functional forms of discounting that the two approaches use.

a. Exponential Discounting

Luus and Mullins (2008)[67] state that exponential (conventional) discounting is based on converting the future costs and benefits of a given project into net present values using a constant, positive discount rate.

To calculate the net present value (PV) of any potential investment, the weighted sum of all future values (FV) is calculated. By using the exponential discounting, the future values will be discounted over time (t) using a constant, positive

[65] **Luus, CW., and Mullins, D., 2008. Ibid. p. 11-14.**
[66] **2Zhuang J., Liang Z., Lin T., and De Guzman F. 2007. Ibid. p14-15.**
[67] **Luus C.W. and Mullins D., 2008. Ibid. p 8.**

discount rate (r). Consistent with the notion of present value calculations, the discount factor is defined as:

$$d_t = 1/(1+r)^t = (1+r)^{-t} \quad (1)$$

Thus, to calculate the net present value, the formula is:

$$PV = FV(1+r)^{-t} \quad (2)$$

Thus, the discount factor declines less in the short run than in the long run. Equation 2 could just be solved for FV, in which case the PV is compounded by the interest rate over the appropriate period:

$$FV = PV(1+r)^t \quad (3)$$

With exponential discounting the discount factor declines exponentially with time, thus attaching ever-declining values to future benefits and costs. However, recent work casts doubts on the conventional discounting method's ability to explain how individuals effectively make choices.

In particular a more general form of discounting that gained importance, in both applied and theoretical work, is hyperbolic discounting which captures phenomena such as procrastination and addiction.

b. Hyperbolic Discounting

Unlike the exponential discounting, hyperbolic discounting is based on converting the future costs and benefits of a given project into net present values using a variable discount rate, so equation 2 becomes:

$$PV = FV/(1+rt) \quad (4)$$

Thus, the discount factor falls more quickly in the short run than the long run.

There is a problem of time inconsistency in the use of hyperbolic discounting, despite the fact that hyperbolic discounting is the best way to calculate the cost and benefit of investment project. It is generally used in the case of investments that have impact on extremely long term.

Methods of calculating the Discount Rate

It is quite easy to determine the social discount rate under a perfectly competitive market model (market without distortions). Under this model, the market clears at a rate where the social rate of time preference (SRTP) for consumption equates the social opportunity cost (SOC) of capital. SRTP for consumption reflects the rate at which people are prepared to trade current consumption for future consumption. The SRTP is equal to households' supply of funds (saving) in the loanable funds market, while The SOC is equal to the demand of funds (investment) in the loanable funds market. In this case the market-clearing rate would be the appropriate social discount rate.

However, in real world were markets are distorted by factors such as government intervention, externality and asymmetric of information; there will be a gap between SRTP, which relates to the returns to savings, and SOC, which relates to the return to investment. It is unclear which one, if either, should be used (in the first place) as the discount rate[68].

Under imperfect competition market, there are various methods of calculating the discount rate for intra and inter-generational projects.

A. Method of discounting an intra-generational projects

Four conventional methods of discounting an intra-generational project can be put forward: (i) Social rate of time preference (SRTP), (ii) Social opportunity cost (SOC), (iii) Weighted average approach, and (iv) Shadow price of capital (SPC) approach.

i. Social Rate of Time Preference

The use of SRTP as the social discount rate is based on the argument that households prefer current consumption to future consumption. Consumers are generally "impatient" or "myopic". Therefore, the appropriate discount rate is the social opportunity cost of forgone present consumption.

The social rate of time preference is the rate at which households are willing to trade a unit of current consumption in exchange for more future consumption[69]. Algebraically, SRTP can be represented as follow:

$$i = r + ug \qquad (5)$$

Where i is the consumption rate of interest, r captures the effect that higher interest rates are required to draw forth a given amount of savings when individuals expect consumption

There are two models of estimating the SRTP. One is the approximation of the SRTP after tax rate of return of the government bond or other low risk marketable securities. The other is the application of Ramsey formula. According to Ramsey's formula derived from a growth model, SRTP is the sum of two terms: the first is a utility discount rate reflecting the pure time preference and the second is the product of two parameters, the elasticity of the marginal utility of consumption and the annual rate of growth of per capita real consumption (Ramsey, 1928)[70].

A major criticism on using SRTP as the social discount rate is that it is purely a measure of social opportunity cost in terms of forgone consumption and ignores

[68] **Young, L. 2002. Determining the Discount Rate for Government Projects. New Zealand Treasury. p. 3.**
[69] **Zhuang J., Liang Z., Lin T., and De Guzman F. 2007. Ibid. p 4.**
[70] **Ramsey, F. 1928. " A Mathematical Theory of Saving." Economic Journal 38:543-59.**

the fact that public project investment can crowd out private project investment due to an increase in the market interest rate. In addition, since SRTP is generally lower than SOC because of the wedge created by market distortions such as taxes, this raises the possibility that too many low return investments in the public sector would be undertaken when SRTP is used as the social discount rate.

However, the SRTP is much more stable parameter than the social opportunity cost rate which tends to fluctuate sharply with the business cycle.

ii. Social Opportunity Cost

The social opportunity cost (SOC) is based on the argument that resources in any economy are scare; that government and private sector compete in the same pool of funds. Everything else being constant, an increase in the demand for public investment will crowd out the demand for private investment. Therefore, the social rate of discount will be the rate of return of the next best alternative use of funds. Generally, the next best alternative use of funds is thought to be the investment of private sector.

Luus and Mullins (2008)[71] sited four models for calculating the social opportunity cost which are: Capital asset pricing models (CAPM); Arbitrage pricing theory (APT), and Fama and French's multi-factor model.

Despite the fact that CAPM currently dominates the other models, the other models are continually challenging this dominance. Lally, cited by Luus and Mullins (2008)[72] concluded that: "All versions of the CAPM along with APT suffer from considerable ambiguity in empirical testing. However, parameter estimation problems appear to be considerably less for the CAPM than for APT, multi-factor models (such as Fama-French) and the dividend growth model. These considerations do not favour any alternative to the CAPM, and this is consistent with the CAPM's dominance in practice."

A major criticism on using SOC as the social discount rate is that it is purely a measure of social opportunity cost of public investment. SOC as the social discount rate assumes that public investment only crowd out private investment and not private consumption, which is not realistic.

iii. Weighted Average Approach

Since SRTP does not take into account the social opportunity cost of public investment and SOC does not take into account the impact of public investment on consumption spending. Several Economists, including Broadman et al (1996)[73], Sadmo and Dreze (1971)[74], have suggested that the social discount rate should defined as the weighted average of the SRTP (usually computed as the post-tax savings rate) and the SOC (usually computed as the pre-tax investment return).

[71] Luus, CW., and Mullins, D., 2008. Ibid. p. 19.
[72] Luus, CW., and Mullins, D., 2008. Ibid. p. 20.
[73] Boarman A.E. et al 1996. CBA – Concepts and Practice; Prentice-Hall Inc; p28-29.
[74] Sadmo, A., and Dreze, J. 1971. "Discount Rates for Public Investments in Closed and Open Economies." Economica 38:395-412.

The discount rate calculated using the weighted average approach could be represented as:

$$\text{Social discount rate} = (\alpha)SOC + (1-\alpha)SRTP \qquad (6)$$

Where α is the proportion of resources or costs that crowd out private investment and $(1-\alpha)$ represent the proportion of resources or costs that crowd out consumption spending. Young (2002)[75] states that there is an issue about setting α, which is project dependent. It may not be clear what the impact will be on private investment and consumption levels.

A major criticism on the weighted average approach is that, while it recognises that costs of public investment can crowd out private investment, it assumes that benefits will be consumed immediately and ignores the fact that they could also be reinvested in private sector, generate future consumption, and bring more social value than crowd out consumption, while ignoring that higher social value of project benefits that are reinvested than immediately consumed, leads to over discounting of project benefits.

iv. Shadow Price of Capital Approach

The shadow price of capital (SPC) approach attempts to reconcile the SRTP approach with that of SOC and, at the same time, addresses the limitation of the weighted average approach. The SPC approach recognises that while costs of a public project can crowd out private investment, its benefits can also be reinvested in the private sector.

The SPC approach involves four steps. The first is estimating SPC, which is the present value of streams of future consumption forgone arising from displacing one unit of private investment or the present value of future consumption streams generated from reinvestment one unit of project benefits in the private sector. The second step involves, for each time period, converting all the costs and benefits that either displace or generate private investment into consumption equivalents by multiplying them by SPC. Third step is adding these cost and benefits to the other portions of costs (in the form of directly displaced consumption) and of benefits (in the form of immediate consumption), respectively. Finally, discount the total cost and benefit streams at SRTP to calculate the net present value (NPV).

Bradford (1975) proposed the following formula for the case when investment returns are perpetual but a proportion of the annual return π is re-invested:

$$\text{Shadow price} = \frac{(1-s)\gamma}{i - s\gamma} \qquad (7)$$

[75] **Young, L. 2002. Ibid. p. 6.**

Where $\gamma = (1+\pi)/(1+i)$, s is the marginal propensity to save, and $s\gamma < 1$. the shadow price increases with the fraction of reinvested.

The SPC approach, although theoretically attractive is difficult to implement. The value of SPC is very sensitive to the values of SRTP and SOC, to how depreciation and reinvestment are assumed, and to the length of life of a project.

What is common to the four approaches described above is that the discount rate, whatever it is, is time-invariant, implying that discounting would be exponential.

B. Method of discounting an inter-generational projects

Luus and Mullins (2007), distinguish between social welfare planner approach and approaches based on existing individual's preferences as methods of calculating social discount rate for extremely long-term projects, which involve unborn generations. The two methods can be described as follow:

- Social welfare planner approach

One popular recommendation is that social discounting for inter-generational policies should be based upon optimal growth analyses. In optimal growth models, the social rate of discount generally equals the sum of two factors. One is a discount rate for pure time preference, which measures the degree to which the social planner favours the utility of current and near future members of society over that of individuals in the more distance future. The other is an adjustment reflecting the fact that the marginal utility of consumption will decline over time as consumption per capital increases (equal to the elasticity of marginal utility multiplied by the rate of increase of consumption over time).

- Approaches based on existing individuals' preferences

The major alternative to the social welfare planner approach for inter-generational discounting is to rely on the preferences of current individuals for an appropriate discount rate. At its core, this perspective rejects the view that the problem is one of balancing the interests of all humans who will live now and in the future. Instead, according to this perspective, it is fundamentally about individuals alive today allocating their scare resources to competing ends, one of which happens to be the welfare of future generations.

The two above methods mentioned make use of hyperbolic discounting when it comes to analyse cost and benefit that occurs in "far future".

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