AN ASSESSMENT OF THE USE OF COST-BENEFIT ANALYSIS IN THE APPRAISAL OF THE ORD RIVER IRRIGATION PROJECT

by

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CHAPTER 1

INTRODUCTION

1.1 OBJECTIVE OF STUDY

The aim of this study is to assess Cost-Benefit analysis as an aid to decision-making for the allocation of public funds between alternative development projects. The concept of Cost-Benefit analysis will first be defined in the light of research that has been conducted on the subject to date. Cost-Benefit analysis will then be evaluated in terms of its value as an aid to decision-making in public investment in Australia.

Cost-Benefit analysis is a methodology, or an approach to a problem rather than an analytical technique. However, it may draw upon analytical techniques to assist in the analysis. Conceptually, Cost-Benefit analysis may be used to analyse economic and social costs and benefits of any investment project. Comparability of such analyses require that projects be of a similar type. For instance, a Cost-Benefit analysis of a new airport will differ markedly from the analysis of an irrigation project in that different objectives are to be met, different criteria are used, and different types of measurement are to be made.

This study will assess Cost-Benefit analysis as a means of appraising and comparing rural development projects. The Ord River Scheme is used as an example because, although it has been one of the most intensively studied irrigation projects in Australia, it has been the centre of controversy since its inception. The controversy has indicated a number of failings in the use and non-use of Cost-Benefit analysis in evaluating development projects.

1.2 GENERAL

Economic growth is a primary economic objective of any government policy. One of the major factors contributing to economic growth is the investment of public funds. These funds are a scarce resource and, hence, should be directed to the best alternative use to achieve a desirable rate of economic growth. Consequently, there is need for adequate evaluation of the alternative uses of these funds. This would involve a comparison of the direct receipts and expenditures of each alternative.

However, government policy has other objectives, particularly the improvement in the welfare of the nation. Therefore, for public investment, in particular, it is necessary to consider not only the direct receipts and expenditures of an investment, but also the effects on society as a whole and on future generations.

Evaluation of investment alternatives in the public sector of an economy therefore requires consideration of the economic and social consequences of each investment opportunity. Many of the techniques which could be used to evaluate investment alternatives in the public sector[1] cover only economic aspects. Cost-Benefit analysis is one method by which both social and economic aspects can be considered[2].

Cost-Benefit analysis has been used in Australia in the appraisal of rural development schemes since 1965. Studies have been done on land development projects[3], road development projects in underdeveloped areas[4], and water-supply schemes[5]. However, these analyses were incomplete in that the social aspects were not considered. Most Cost-Benefit analyses have been conducted

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1. For a critical comparison of the various techniques see: Muthoo, M.K. (1970) - "Investment Analysis Techniques with Emphasis on Cost-Benefit Analysis and Renewable Resource Planning", World Agricultural and Rural Sociology Abstracts, Vol. 12, No. 2, pp. 19-38.

2. Dasgupta, A.K. and Pearce, D.W. 1972. Cost-Benefit Analysis Theory and Practice. Macmillan, pp. 11-16.

3. The Economics of Brigalow Land Development in the Fitzroy Basin, Queensland. Bureau of Agricultural Economics, Commonwealth Government Printer, Dec. 1963.

4. Economic Analysis of Road Development in the Northern Territory Buffalo Area (Beatrice Hill to Oenpelli Mission), Bureau of Agricultural Economics, Commonwealth Government Printer, Dec. 196

5. Extension of the Comprehensive Water Supply Scheme (Agricultural Areas of Western Australia): An Economic Evaluation. Bureau of Agricultural Economics, Commonwealth Government Printer, Aug. 1965.

on irrigation projects. Prior to 1965, evaluation procedures regarded a scheme as successful, from the nation's point of view, if "... the gross revenue created by the scheme gave a satisfactory return on the capital the state had invested"[6]. Again this criterion is incomplete in that social costs and benefits are ignored. In addition, this criterion excludes private operating costs and private capital from the calculation. Since 1965 the Federal Treasury[7] has insisted that requests for assistance with irrigation projects should be accompanied by a Cost-Benefit analysis, incorporating private capital and operating cost, but specifically excluding intangible effects[8]. Most social costs and benefits are intangible and therefore these would be excluded.

Conflicting results may be obtained from different appraisals of the same project. Much of this conflict arises from the use of criteria, such as Net Present Value and Internal Rate of Return, which are economic criteria. Social effects resulting

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6. Davidson, B.R. 1969. "Benefit-Cost Analysis of Irrigation Projects in Australia", Paper presented to the Statistical Society of New South Wales Symposium on Forecasting, University of Sydney, Aug. 1969 (mimeo).

7. "Investment Analysis", Commonwealth Treasury Information Bulletin Supplement, July 1966.

8. ... Although it was proposed that such "intangibles" should be considered at the interpretation stage.

from public investments cannot be analysed in terms of such criteria. Principles of welfare economics were used to develop criteria so that social effects of investment projects may be analysed. These principles assume that the economy is perfectly competitive, while most investment decisions are made in an imperfectly competitive economy. This creates problems in the valuation of costs and benefits. These problems plus the confusion created by implied objectives[9] have prevented a rigorous and complete application of Cost-Benefit analysis. For a systematic comparison of alternative projects a well-defined, rational means of comparison is required. Consequently, there is need for a clear statement of the approach used to apply Cost-Benefit analysis.

1.4 OUTLINE OF STUDY

The logical basis and scope of Cost-Benefit analysis are discussed in Chapter 2. Chapter 3 outlines and defines an ideal Cost-Benefit analysis, while the valuation of costs and benefits in Cost-Benefit analysis is discussed in Chapter 4. Chapter 5 presents a background to the Ord River Irrigation Scheme. The use of Cost-Benefit analysis in appraising the Ord River Scheme

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9. Such confusion results from the fact that objectives are implied rather than being clearly stated.

is then assessed in relation to the objectives, primary effects, and secondary effects of the scheme, respectively in Chapters 6, 7 and 8. Chapter 9 will present a summary of the study, outline the conclusions, and present some recommendations.

CHAPTER 2

THE LOGICAL BASIS AND SCOPE OF COST-BENEFIT ANALYSIS

2.1 INTRODUCTION

Cost-Benefit analysis has been proposed as a methodology, or technique, which can act as an aid in rational decision-making. Specifically, it is a technique which attempts to estimate all costs and benefits that would result from alternative projects. It involves identification of economic and social costs and benefits. It requires that alternatives be compared by decision rules, or criteria, in terms of their value to the community. Criteria are standards used to measure the value of an objective function. Alternative projects are ranked for comparison according to the value of the objective function. Therefore, the definition of the costs and benefits to be included in the analysis, their measurement, and the appropriate criteria are all related to the objective function.

It is the objective function which is maximised. Cost-Benefit analysis works with an objective function defined in terms of net social benefits. The criteria, which may be used in Cost-Benefit analysis compare alternatives in terms of net economic benefit and net social benefit. Economic criteria are discussed in Chapter 3.

Social criteria have been derived from welfare economics. Welfare economics defines a social benefit as one which involves a Pareto improvement. Therefore, net social benefit is defined by the Pareto criterion. The Kaldor-Hicks criterion, or compensation principle, qualifies certain pitfalls in the Pareto criterion[10]. These two criteria are the basic social criteria used in Cost-Benefit analysis. This chapter will discuss the Pareto criterion and compensation principle, their use in Cost-Benefit analysis, and a modification necessary for their application.

2.2 PARETO OPTIMALITY AND THE COMPENSATION PRINCIPLE

(a) Pareto Optimality

The objective of Cost-Benefit analysis has been defined as being "... to guide the decision-maker in choice of capital projects and expenditures which will maximise the gains to social welfare"[11]. More precisely, its purpose is to guide the decision-maker in the choice between public investment projects so as to maximise the net benefits to society as a whole. This should provide for more rational decision-making.

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10. Other criteria, particularly the Little Criterion, provide further logical extensions to these two criteria. However, the Pareto and Kaldor-Hicks criteria are the basic criteria of welfare economics.

11. Dasgupta and Pearce, op. cit., p. 44.

Rational choice has been defined[12], for the individual, as the ordering of alternatives so as to achieve his 'most preferred state'. The alternatives would be ranked according to the utility, or the 'preferedness' of each to the individual. For a society of one individual the 'most preferred state' would be achieved by ranking alternatives according to the utility of each.

Difficulties arise in defining the link between the utility of an alternative to an individual, and the benefit of an alternative to society. Welfare economics has been developed to provide such a link[13]. This is accomplished through the aggregation of individuals' utilities into a social welfare function. Consequently, social welfare is related to some aggregation of individuals' preferences through welfare economics.

Welfare economics further propounds that, in the market utilities will be reflected in prices, generally speaking, and this, in turn, reflects 'willingness to pay'. Therefore, social welfare may be represented by the aggregation of individuals' willingness to pay. This implies that the objectives of Cost-Benefit analysis is to aid the decision-maker to choose outcomes which are socially 'most preferred'[14].

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12. Ibid., p. 24.

13. For a summary of welfare economics see: Mishan, E.J. "Survey of Welfare Economics", Economic Journal, 1960.

14. This statement must be qualified by the fact that no complete allowance is made for differing intensities of preference between individuals.

It follows from this that there must be some overall state of the economy which is socially 'most preferred'. This state is the social optimum, or Pareto optimum. Such a state is defined as being one in which no-one can be made better off without someone being made worse off. Hence the Pareto criterion considers a change as desirable if it moves some persons to positions they prefer, and moves no-one to a position preferred less than the present one[15]. Therefore, the aim of Cost-Benefit analysis can be redefined as that of guiding choices such that the 'most preferred', or Pareto optimal, state is achieved.

(b) The Compensation Principle

A change that would make some people better off and others worse off is not evaluated by the Pareto criterion. However, most projects do involve gains to some and losses to others. Therefore, the Pareto criterion requires some refinement. This is supplied by the Compensation principle, or Kaldor-Hicks criterion. This criterion states that "... If A is made so much better off by a change that he could compensate B for his loss and still have something left over, then the change is an unequivocal improvement"[16]. The criterion involves

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15. Merewitz, L. and Sosnick, S.H. 1971 The Budget's New Clothes: A Critique of Planned Programme Budgeting and Cost-Benefit Analysis. Markham Publishing Co., p. 78.

16. Dasgupta and Pearce, op. cit., p. 57.

no actual compensation. However, Pareto optimality is preserved if the gainer still benefits even after compensating losers so that they are no worse off.

This is analagous to the objective function assumed for Cost-Benefit analysis. That is, if the value of the benefits exceeds the value of the costs, the gainers can hypothetically compensate the losers and still have some left over. The excess of gains over required compensation is equivalent to the net benefits of the project[17]. Consequently, if costs are valued at opportunity cost, and benefits exceed the costs of a project, under the compensation principle the project would result in an improvement in national welfare, whether or not gainers compensate losers[18].

2.3 THE SCOPE OF COST-BENEFIT ANALYSIS

Cost-Benefit analysis is used primarily to compare alternative projects. Therefore, determining the relevant alternatives to be considered is important in any Cost-Benefit analysis. The range of alternatives should not be too limited or too extensive.

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17. As the Kaldor-Hicks criterion assumes no actual compensation, then it also implicitly assumes that the initial income distribution is optimal.

18. For a clear description of the theory itself see: Hibdon, J.A. 1969. Price and Welfare Theory. McGraw Hill Inc., pp. 455-456.

Consideration of a very limited range of alternatives may not lead to the choice of the best project, as the best alternative may not have been considered. Similarly, consideration of a very wide range of alternatives may be wasteful in that some of the alternatives considered may obviously not have been chosen.

The choice of the appropriate alternatives is related to the criteria used[19]. It has already been established that the appropriate social criteria in Cost-Benefit analyses are the Pareto criterion and the Compensation principle. Therefore the choice of the range of alternatives must be related to these criteria.

Both these criteria are means of determining what society prefers. The determination of what society prefers is achieved by the aggregation of individual preferences through welfare economics. However, the Arrow Impossibility Theorem[20] was proposed to show that such aggregation is not possible without introducing value judgements into the analysis. The Impossibility Theorem consists essentially of five criteria of 'reasonableness', all of which must be satisfied before the conflicting desires of a large number of individuals can be aggregated into a meaningful social welfare function. Arrow postulates that aggregation

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19. Dasgupta and Pearce, op. cit., p. 90.

20. Ibid., p. 92.

cannot be achieved without violating at least one of these criteria.

If this theorem holds, then welfare economics has no logical basis. Consequently, Cost-Benefit analysis would have no objective social criteria and would need to rely on subjective social criteria. It would involve estimating trade-offs between the various objectives of government policy in compiling Cost-Benefit analyses. However, the use of value judgements can be greatly reduced through limiting the use of Cost-Benefit analysis to assessing similar projects.

CHAPTER 3

OUTLINE OF COST-BENEFIT ANALYSIS

The form of Cost-Benefit analyses may vary according to the particular investment alternatives being evaluated. However, there are a number of elements common to all such analyses[21]. These include:

(1) The objective function.

(2) The benefitsto be achieved.

(3) Costs, or the benefits that must be foregone if one of the alternatives is adopted.

(4) Models, or sets of relationships which can help evaluate the impact of each alternative on benefits and costs.

(5) Constraints.

(6) Criteria.

These elements of Cost-Benefit analysis will be discussed in this chapter.

(1) The Objective Function

The objectives of an investment project are the major element in any project evaluation. Not only the benefits and

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21. Five of the elements are outlined in: McKean, R.N. 1968. Public Spending. McGraw-Hill Inc., p. 136. Prest and Turvey, op. cit., pp. 700-702 include constraints as another common element.

costs, but also criteria and evaluation methods are related to the objective function. The most common objectives for public investment are the achievement of a desirable rate of economic growth, and desirable income distribution. In order to achieve a desirable rate of economic growth it would be necessary to attain a high level of economic efficiency. This may be attained by maximising the net social benefits of public investment.

It was established in the last chapter that Cost-Benefit analysis works with a Pareto-type objective function. Ranking public investment alternatives according to the Pareto criterion would lead to the maximisation of net social benefits, while maintaining the original income distribution. Therefore, the objective function of Cost-Benefit analysis appears to be to maximise both economic efficiency and national welfare. However, this assumes that the present income distribution is optimal. This assumption has been debated. Maas[22] argues that economic efficiency is not an adequate objective in the evaluation of public investment opportunities, but that there should be a trade-off between this and income redistribution objectives. There have been a number of attempts to include this objective

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22. Maas, A. 1966. "Benefit-Cost Analysis; Its relevance to Public Investment Decisions". Quarterly Journal of Economics, Vol. 80, No. 2, pp. 208-226.

in Cost-Benefit analysis[23]. However, few have been entirely successful. An opposing view[24] has been that the introduction of income redistribution objectives into the analysis would involve the necessity of quantifying value judgements to determine trade-offs between objectives. Limiting the objective function of the analysis to efficiency and welfare objectives enables a more consistent means of ranking public investment alternatives.

This debate has not been resolved. However, the Pareto criterion and, hence, efficiency and welfare objectives have traditionally constituted the objective function of Cost-Benefit analysis. In addition, no reliable means of incorporating income redistribution objectives into Cost-Benefit analysis has been devised. Therefore, in this study it will be assumed that the objective function of Cost-Benefit analysis is limited to effiency and welfare objectives only.

(2) Benefits

Objectives may be defined as the benefits which a particular investment project hopes to achieve. Economic efficiency and the

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23. For a consideration of such attempts and the problems involved see: McColl, G.D. and Throsby, C.D. 1971. "Regional Multiplier Estimation in Benefit-Cost Analysis and Possible Application in Australia", Australian New Zealand Association for the Advancement of Science 43rd Congress, Brisbane, May 1971, Section 24.

24. McKean, R.N. 1958. Efficiency in Government Through Systems Analysis: With Emphasis on Water Resource Development. Publications in Operation Research No. 3, New York, John Wiley and Sons Inc., pp. 131-133.

improvement in the welfare of a nation are the overriding objectives of Cost-Benefit analysis. However, these objectives may be divided into lesser objectives, all of which contribute to these two major objectives. These are the potential benefits of the project.

The benefits of a project may be defined as the increased value of goods and services resulting from the project[25]. Benefits from an increase in quantities and services relate to such objectives as economic efficiency and economic growth. The social benefits relate to an improvement in the welfare of a nation.

Consequently, the benefits of a project can be divided into two distinct types in the evaluation. These are the primary benefits and the secondary benefits.

(a) Primary Benefits

The primary benefits of a project can be defined as the value of outputs directly resulting from a project[26]. These are usually given net of all the associated costs incurred in their realisation, to differentiate these costs from the project costs[27].

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25. Ibid., p. 151.

26. Subcommittee on Evaluation Standards, Proposed Practices for Economic Analysis of River Basin Projects, May 1958, p. 8.

27. These are discussed in Section 2.

These are the direct economic consequences of the project.

(b) Secondary Benefits

Secondary benefits are those that occur as a result of the project but are external to the project itself. They include indirect economic benefits and all social benefits. Therefore, they include the uncompensated effects of a project on the outputs of producers other than those directly involved in the project, or on the satisfactions of consumers[28]. These benefits are often termed externalities, or technological spillovers, because of their indirect nature. They affect Pareto optimality, and therefore should be included in the analysis as secondary benefits.

Other spillover effects of a project are pecuniary spillovers. Such spillovers affect production possibilities, or output, and satisfactions through changed prices. They may include the effects of a project in:

(i) raising prices of inputs used at the project;

(ii) altering prices of substitutes and goods complementary to inputs used at the project;

(iii) lowering prices of substitutes to goods produced at the project;

(iv) raising prices of complementary products;

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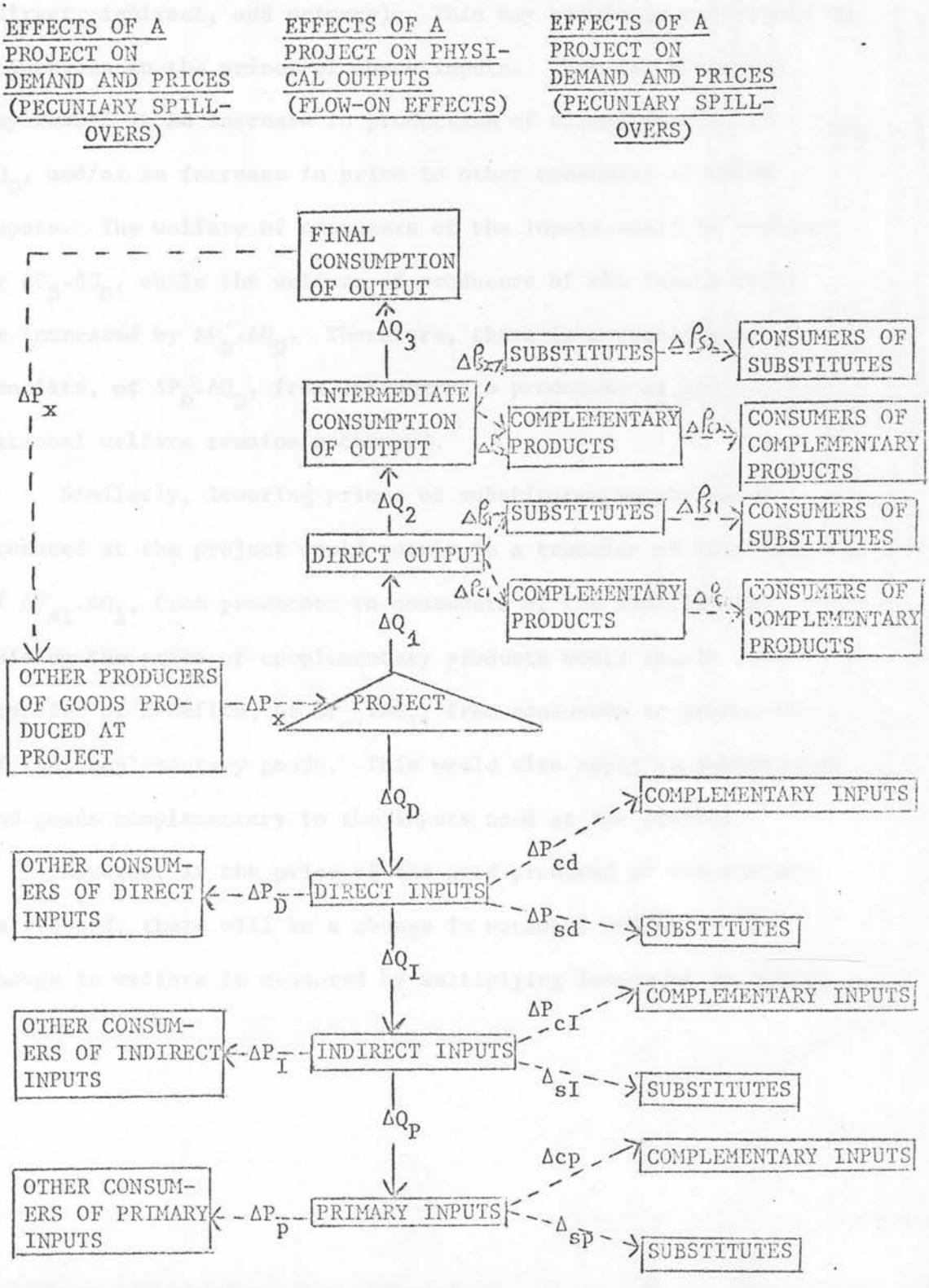
28. Interdependence effects, such as envy, are not regarded as permissable secondary effects, as failure to include these in the analysis will not affect Pareto Optimality.

FIGURE 3.1

PECUNIARY SPILLOVERS AND FLOW-ON EFFECTS OF A PROJECT



KEY:

= OUTPUT EFFECTS

= DEMAND OR PRICE EFFECTS

ΔQ = CHANGE IN QUANTITY

ΔP = CHANGE IN PRICE

by the increment in price[29]. This reflects both the reduced welfare of producers and the increased welfare of consumers of the good. It is the incremental value, $\Delta P_x.\Delta Q_x$, rather than the absolute value, $P_x.Q_x$, that represents the effect of the project on national welfare. The original value, $(P - \Delta P_x).(Q - \Delta Q_x)$, is transferred from producers to consumers and does not alter national welfare. Similarly, if the goods produced at the project are exported, the incremental value will reflect the effect of the lowered price of the good on national welfare.

Further benefits arising from a project would be flow-on benefits. Such flow-on benefits would occur when output of industries supplying inputs to the project is increased (ΔQ_D, ΔQ_I, and ΔQ_P) because of the project. They also occur when output of a project results in greater activity by the intermediate consumers of that output (ΔQ_1, ΔQ_2, and ΔQ_3).

However, Cost-Benefit analysis evaluates the effects of a project on the particular sectors of the economy with which the project is concerned. It does not evaluate the effects of that project on other sectors of the economy. That is, it adopts a partial equilibrium approach. Therefore, the extra output (ΔQ_I and ΔQ_P) of suppliers of inputs to the project is reflected in the costs of the project. Similarly, the extra output

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29. McKean. 1958. op. cit., pp. 136-141.

(ΔQ_2 and ΔQ_3) of intermediate consumers of the produce of the project is reflected in the extra output of the project.

In addition, Cost-Benefit analysis compares only similar projects. The flow-on benefits of similar projects would be of a similar type, although they may differ in magnitude. However, since Cost-Benefit analysis uses a partial equilibrium approach, the magnitude of such flow-on benefits would be reflected in the net primary benefits of the project. Therefore, in a comparison of similar projects, any differences in magnitudes of flow-on benefits of each project would be considered in comparison of net primary benefits.

Consequently, secondary benefits, in Cost-Benefit analysis, include the effects of a project on outputs of producers external to the project which are directly attributable, and unique, to that project. In addition, they include effects of the project on the satisfactions of consumers.

(c) Costs

The costs of adopting a project are the benefits of the alternative uses of the economic resources used which have to be foregone. The use of resources in any project precludes their use for other purposes. Consequently, the cost of using these resources is an opportunity cost[30].

30. Opportunity costs are discussed in Chapter 4.

The existence of spillovers in the market necessitates the evaluation of secondary as well as primary costs, as was the case for benefits.

Primary costs include "Project Costs" and "Associated Costs". Project costs are the outlays incurred in the establishment, operation and maintenance of the particular investment[31]. Associated costs can be defined as " ... any costs involved in utilizing project services in the process of converting them into a form suitable for use or sale at the stage benefits are evaluated"[32]. They are the costs incurred in producing the benefits and are deducted from the primary benefits in the analysis.

Secondary costs can be divided into pecuniary and technological effects in the same way as benefits. The technological effects only are included in the analysis, while distributional and flow-on items are not.

(4) Models

Projects, or investment alternatives, must be defined before costs and benefits can be determined. A project may consist of a number of relationships which must be considered in its definition. In addition, the project must be considered in relation to the

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31. Sub-committee on Evaluation Standards, op. cit., p. 8.

32. Ibid., p. 9.

economy, and society, as a whole. Consequently, there are many relationships which must be considered in the determination of the costs and benefits of a project.

Models are representations of these relationships and can be used to estimate costs and benefits. There are several broad sets of relationships which must be modelled for any project. The importance of any particular set of relationships will depend on the particular project. Such relationships[33] include:

(a) The external economic relationships which relate the project to the rest of the economy. They include both primary and indirect secondary, or economic, effects.

(b) The physical relationships, including project engineering and the agricultural, or farm, system for agricultural projects. They incorporate, therefore, both primary and secondary social effects.

(c) The internal economic relationships of the project. They include only primary effects.

(a) External Economic Relationships

The external economic relationships are those that are largely determined external to the system. They include market

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33. These relationships are discussed in: Manual on Economic Development Projects, United Nations, 1958.

relationships, input-output relationships, and those relationships used in determining the optimal size and location of the project.

Models of market relationships must be developed to determine the capacity of production of the project, and to estimate probable income throughout the economic life of the project[34]. This requires estimation of present and future demand for the outputs of projects. It will aid in determining the volume of output required to meet this demand and, hence, the capacity of production to be built into the project. Assumptions must be made as regards future economic policy in the estimation of these relationships.

The input-output relationships also need to be determined for the various outputs of a project. This relates the project to the rest of the economy and may aid in determining any indirect economic effects which may be included in the analysis.

The relationships used in the determination of the best size and location of a particular project include the market relationships determined previously, and production costs of the project. Size and location are interrelated and both must be

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34. The economic life of a project depends on a number of factors including rate of interest, physical life of the project, technological changes, shifts in demand, emergence of competing outputs and so on.

optimised to minimise costs. Consequently, locational as well as physical production costs must be determined.

(b) Physical Relationships

The estimation of physical relationships in the project are useful in determining both primary and social benefits and costs. Two sets of physical relationships are generally determined for any project. These are the engineering relationships and, in the case of development projects, the physical relationships affecting the economic units of the project.

The importance of physical relationships in a Cost-Benefit analysis will depend on the particular project. For an irrigation project, for instance, measurement of river flows and flood frequencies may be important in the determination of such benefits as the supply of hydroelectric power and flood control. However, measurement of physical relationships would be of little use in the evaluation of a new hospital scheme. Similarly, for irrigation projects, the determination of relationships between the physical environment and the system of farming would be necessary in the determination of what can be grown, and resource requirements. Estimation of such relationships would also be useful in determining the social effects of a project on the surrounding environment.

(c) Internal Economic Relationships

The internal economic relationships involve mainly those relationships that exist within the economic units of the project. Consequently, they would not involve any secondary effects. Gross incomes will be determined by both the physical relationships and external economic relationships. Similarly, primary costs may be determined by physical and external economic relationships. The internal economic relationships involve the interrelationship between gross incomes and associated costs.

This interrelationship can be summarised, or modelled, using a budget of income and expenditure. Such a budget can be constructed for the economic units involved in the project, or on a project basis for individual enterprises. Aggregation of the items in the budget can be used in the calculation of primary benefits and costs. Allowance should be made in these budgets for uncertainty in future outputs and prices[35].

(5) Constraints

The existence of constraints of any kind causes complications in the ranking of alternative investments. Therefore, they must be considered in any Cost-Benefit analysis.

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35. This will be discussed in Chapter 4.

The most common constraint is the supply of public funds for either, or both, the capital costs and the running costs of the project. Prest and Turvey[36] have indicated that uncompensated income redistributional effects may be included in the analysis as constraints. Other constraints include physical constraints on the production possibilities of a project, legal constraints, and administrative constraints.

Where constraints do exist, net benefits should be maximised subject to these constraints.

(6) Criteria

Criteria are indicators of how well the objectives are achieved. There are several types of criteria used in Cost-Benefit analysis. There are the social criteria and economic criteria. The social criteria include the Pareto criterion and the Compensation principle. The types of benefits and costs to be included in the analysis and the means used to value them are determined by the social criteria. These have already been discussed.

The economic criteria are indicators of the economic efficiency of the project. They comprise two different types. These are the analytical criteria, such as net benefits, and investment criteria, such as Net Present Value.

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36. Prest, A.R. and Turvey, R. 1965. "Cost-Benefit Analysis: A Survey". The Economic Journal, Dec. 1965, pp. 683-735.

(a) Analytical Criteria

There are three analytical criteria which may be used in ranking projects. They all compare the benefits and costs of alternative projects. Such criteria include:

(i) Net benefit, or excess benefit over cost.

(ii) Ratio of benefit to cost.

(iii) Ratio of net benefit to cost, or ratio of excess benefit to cost.

If alternatives are ranked according to each of these criteria they will not necessarily receive the same ranking[37]. This raises the problem of which is the most rational criterion. The net benefit criterion does not take into account the size of the capital outlay. It therefore implicitly assumes that no increase in the size of alternative investments is possible[38]. Because of this it may be biased towards larger projects[39]. The ratio of benefit to cost criterion avoids this problem by assuming that each of the alternative investments may be increased in any proportion. However, this criterion neglects consideration of the absolute magnitudes of benefits and costs. Therefore, project selection on the basis of the ratio of benefit to cost

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37. Mishan, E.J. 1972. Cost-Benefit Analysis: An Informal Introduction. London, George Allen & Unwin Ltd, pp. 232-233.

38. Ibid., p. 234.

39. If a budget constraint is included this bias may be avoided.

criterion may not produce the maximum net benefits to society. The ratio of net benefit to cost criterion considers both capital outlay and net benefits. It therefore appears to be the most rational of the three criteria, although it is not free of problems[40].

(b) Investment Criteria

All three of the analytical criteria implicitly assume that benefits and costs accrue to a project in a lump sum rather than over a period of time. Investment criteria have been proposed which take into consideration the fact that net benefits will accrue throughout the economic life of the project. The two most useful investment criteria are Net Present Value, and Internal Rate of Return[41]. Both of these allow for changing annual net benefits. However, both do have problems in practical application. For instance, Net Present Value will vary with

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40. Mishan, op. cit., pp. 235-236.

41. Net Present Value is the sum of all net benefits when discounted to their present value, or

$$NPV = \sum_{t=0}^{n} \frac{B - C}{(1-r)^t}$$

where B-C = net benefit at time "t";
r = rate of discount.

Internal Rate of Return is the rate of discount when Net Present Value is zero or r^* when

$$\sum_{t=0}^{n} \frac{B - C}{(1-r^*)^t} = 0.$$

rate of discount, while there may be more than one Internal Rate of Return for a given investment stream. However, the Internal Rate of Return neglects reinvestment opportunities of the benefits of any project. Therefore, it has been argued that Net Present Value provides the most rational ranking of alternatives[42].

Investment of public funds in a particular project will be at the expense of present consumption[43]. Therefore, there will be a trade-off between present and future consumption. This trade-off is reflected in the rate of discount. If this rate of discount has been generated in a perfect market, it will reflect society's rate of time preference, and is the relevant rate of discount to use in the present value criterion. Market imperfections, particularly uncertainty, may cause the market rate of discount to diverge from the social rate of time preference[44]. However, the difficulties of determining the social rate of time preference have so far proven insurmountable. Therefore, the market rate of discount must be used as an approximation.

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42. Mishan, op. cit., pp. 226-234.

43. Qualifications to this are discussed in Chapter 4.

44. For a description of this divergence see: Mishan, op. cit., p. 213.

Mishan[45] has developed a 'Normalisation Procedure' which will enable equivalent ranking of alternatives by all criteria. This procedure involves normalising all criteria in terms of three conditions:

(i) that reinvestment opportunities of all benefits be explicit and fully utilised;

(ii) that a common outlay, and

(iii) a common investment period, be established for each alternative.

If all three conditions are met, alternatives will be ranked uniquely irrespective of which criterion is used.

However, as yet this procedure has not been practicable. Consequently, the present value of the ratio of net benefit to cost criterion, discounted with the market rate of discount, will be regarded as the appropriate criterion.

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45. Ibid., pp. 235-257.

CHAPTER 4

VALUATION OF BENEFITS AND COSTS

4.1 INTRODUCTION

There are several approaches to the valuation of costs and benefits. Benefits may be valued using market prices or willingness to pay. Costs may be valued using market prices or opportunity costs. In a perfectly competitive economy market prices would equal marginal cost and, therefore, both willingness to pay and opportunity cost. However, in an imperfectly competitive economy, market prices deviate from marginal cost and, hence, do not measure true willingness to pay or opportunity cost.

4.2 VALUATION IN A PERFECTLY COMPETITIVE MARKET

Ideally benefits should be valued using willingness to pay. Similarly, costs should be valued using opportunity cost. Investment in a project involves the use of resources in this particular project rather than in another. Therefore, there is an opportunity cost.

Opportunity costs may be measured by the ratio of willingness to pay for the alternatives. This ratio is also known as the 'shadow price'. Shadow prices have been defined as those

that "... are implicit in exchanges that should be made to maximise a particular objective function"[46]. They can be thought of as the marginal rate of substitution between the alternatives in question[47], and represent the amount of one output that must be foregone to obtain another output. Therefore, the shadow price of a benefit is merely the willingness to pay for that benefit.

The precise value of a shadow price will depend on the objective function. Cost-Benefit analyses generally have a Pareto-type objective function, with existing income distribution being regarded as optimal. It should be emphasised that the Pareto criterion is an ideal concept which reflects only one set of value judgements about individual preferences. Another criterion would reflect a different set of value judgements about individual preferences. Consequently, the set of shadow prices implicit in Pareto optimality are unique for this criterion.

Given the conditions necessary for Pareto optimality, it can be shown that the shadow prices, or opportunity costs, of inputs are equivalent to their 'value of marginal product'[48].

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46. McKean, R.N. 1968. "The Use of Shadow Prices" in R. Layard (Ed.) 1972. Cost-Benefit Analyses. Penguin Books.

47. Dasgupta and Pearce, op. cit., p. 97.

48. Value of Marginal Product (VMP) = Price x Marginal Product. Proof of such a relationship between VMP and shadow prices is given in: Dasgupta and Pearce, op. cit., pp. 101-103.

Such shadow prices, as they are the relevant ones to satisfy the Pareto criterion, are also the relevant ones in the valuation of costs and benefits in Cost-Benefit analysis. In situations where this relationship between prices and 'value of marginal product' holds, market prices would be the same as the requisite shadow prices. This relationship holds only where price and marginal cost are equal. This occurs only under conditions of perfect competition[49]. Therefore, in a perfectly competitive market, market prices will represent the willingness to pay, or opportunity cost, of a benefit or a cost in Cost-Benefit analysis.

4.3 PROBLEMS OF VALUATION IN PERFECTLY COMPETITIVE MARKETS

Although market prices do, generally, represent the appropriate shadow prices in a perfectly competitive market, there are situations where this relationship may not hold. Such situations include those where external effects exist, where there are non-marginal changes in price, and in the valuation of project cost. The 'second best' problem may also create difficulties in valuation of benefits and costs at market price.

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49. A perfectly competitive market is defined as being one in which there are a large number of buyers and sellers, all with complete knowledge (i.e. there is no uncertainty). Goods are regarded as homogeneous and, consequently, all buyers and sellers have a large number of alternatives open to them, between which they are indifferent. Lastly, there is perfect mobility of resources so that there will always be a large number of buyers and sellers in the market. In such a market, price, or average revenue, equals marginal revenue and, therefore, marginal cost.

(a) External Effects

An external effect exists if the action of one person affects either the utility, or the production level, of another. Such effects are not priced in a market. If compensation is paid by a producer for the disutility an external effect causes another, then it becomes part of the producer's cost. It is then no longer an external effect. External effects are, therefore, generally both intangible and uncompensated. Consequently, there is no market price to guide in the valuation of such effects.

The existence of external effects in a perfectly competitive market results in marginal cost not reflecting the true social opportunity cost of resources. Therefore, such effects should be included in the analysis. Where such effects are included in the analysis the appropriate shadow price becomes the social opportunity cost, or marginal social cost, of the resources. The values of external effects need to be imputed because of their intangibility. There are a number of approaches to such imputation of values[50]. These are generally

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50. For a critical review of the various approaches see: Sinden, J.A. 1967. "The Evaluation of Extra-Market Benefits: A Critical Review". World Agricultural and Rural Sociology Abstracts, Vol. 9, No. 4, Review Article 7.

attempts to estimate willingness to pay[51].

(b) Non-Marginal Changes in Price

Difficulties in valuation also occur when the investment alters the price of the output. This results in non-marginal changes in price. In the past, an average of the new and old price was used as an approximation of willingness to pay. However, this assumes a linear demand curve. As a result there are a number of problems in using this method[52]. As yet no means of overcoming these difficulties has been devised. Therefore, it would seem that using the average of the new and old prices is still the best method.

(c) Valuation of Opportunity Cost of Project Costs

Opportunity costs of project costs are the benefits foregone in consumption, private investment, or in other public investment projects. This occurs because funds for project costs can be drawn from the consumption, private investment, or public investment sectors.

The opportunity cost can be approximated by adjusting the actual cost by an appropriate rate of discount. The rate of discount acts as a measure of the trade-off between the use of

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51. The most useful concept in estimating willingness to pay is Consumer's Surplus. For a description of this see: Mishan. 1972, op. cit., pp. 31-47.

52. These are discussed in: Dasgupta and Pearce, op. cit., p. 60.

funds for this project and the alternative uses of these funds. However, because these funds may be drawn from different sectors, the determination of a single rate of discount to account for all these trade-offs is difficult. Consequently, two rates of discount have been proposed. These are the private discount rate, or the internal rate of return on private investment, and the social discount rate[53].

In a perfectly competitive capital market, if funds are drawn from the private investment sector, the private rate of discount would be used to determine the opportunity cost of these funds. If funds are drawn from consumption, or taxation, the social discount rate would be used to determine the opportunity cost of consumption foregone. However, if funds are drawn from the public investment sector, or loan raisings, the opportunity cost would be more difficult to determine. This difficulty results from the need to determine the opportunity cost, not only of public investment opportunities foregone, but also reinvestment opportunities foregone.

In an imperfectly competitive market further difficulties arise. For funds drawn from consumption, or taxation, the opportunity cost may still be determined using the social rate

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53. These are outlined in Musgrave, R.A. 1969. "Cost-Benefit Analysis and the Theory of Public Finance". Journal of Economic Literature, Vol. 7, No. 3, pp. 797-806.

of discount. However, difficulties arise in determining the opportunity cost of funds drawn from private investment, while the difficulties involved in determining the opportunity cost of funds drawn from public loan raisings are accentuated[54].

(d) The 'Second Best' Problem

A fourth problem that arises in valuation is the 'second best' problem. Costs and benefits are valued at their social opportunity cost and, if benefits exceed the costs of a project, then proceeding with the project will be a move towards the Pareto optimal state.

However, all sectors of the economy are interrelated and a change in price in one sector may lead to a change in price in all other sectors. Consequently, the pricing policy adopted for any one sector is related to the pricing policies of all other sectors. Lipsey and Lancaster[55] in their "Theory of Second Best" maintain that the adoption of any pricing policy, in any sector of the economy, will not necessarily be a move towards a Pareto optimal state, unless all other sectors of the economy adopt the same pricing policy. An extension of this argument is that the adoption of social opportunity cost

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54. Ibid., pp. 110-111.

55. Lipsey, R.L. and Lancaster, K. 1956/57. "The General Theory of Second Best", Review of Economic Studies, 1956/57.

pricing will not guarantee a move towards a Pareto optimum and may, in fact, move the economy away from this state.

Because of the 'second best' problem, the use of social opportunity cost in Cost-Benefit analysis may be misleading unless a general equilibrium approach is adopted. There has been a good deal of disagreement over the implications of this problem, and possible solutions to it[56]. The 'second best' theorem has been criticised as being largely inapplicable[57]. In addition, there is evidence[58] that interdependence between all sectors of the economy is not so marked as to make the 'second best' theorem such a major problem. There may be sectors which play a major role in any economy. Consequently, in the determination of shadow prices, it may be necessary to consider the interdependence only between the sector under consideration and these major sectors. Therefore, the cost of obtaining more accurate estimates of social opportunity cost, through a general equilibrium approach, may be greater than the benefit obtained[59].

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56. See for example: McKean, op. cit., pp. 124-125; Turvey, R. 1968. Optimal Pricing and Investment in Electricity Supply London, Ch. 8; Rees, R. "Second Best Rules for Public Enterprise Pricing", Economica, Aug. 1968; Wiseman, J. "The Theory of Public Utility Price: An Empty Box", Oxford Economic Papers, 1957.

57. Davis, O. and Whinston, A. "Welfare Economics and the Theory of Second Best". Review of Economic Studies, 1966.

58. Peacock, A.T. and Dosser, P. "Input-Output Analysis in an Underdeveloped Country: A Case Study", Review of Economic Studies, Oct. 1957.

59. McKean. 1968, op. cit., p. 133.

4.4 VALUATION IN IMPERFECTLY COMPETITIVE MARKETS

Although market prices do play a central role in the valuation of benefits and costs, substantial modifications often need to be made to these to allow for market imperfections. This results from the fact that in an imperfectly competitive market, price and marginal cost diverge. There are a number of market imperfections which may require adjustments to market price including imperfect competition, unemployment of resources, taxation and subsidies, public goods, and uncertainty.

(a) Imperfect Competition

There may be imperfect competition in either, or both, the product and factor markets.

In the product market monopoly elements, or product differentiation, will cause price to be above marginal cost. The degree to which price diverges from marginal cost is dependent on the degree of monopoly, or other imperfections, existing in the market. In markets where the degree of monopoly is small, market prices may be reasonable approximations for the appropriate shadow prices. However, in general, market price will overstate the value of the output. Monopoly elements in the product market may also be generated by increasing returns in certain industries. The existence of increasing returns will mean that valuation at market price will underestimate the cost

of the resources to the enterprise. A similar situation exists for the factor market.

(b) Unemployment of Resources

A second market imperfection is the unemployment, or under-employment, of resources. This imperfection is more concerned with the valuation of costs than benefits. If an unemployed resource is used in a project, then its shadow price, or social cost, is zero. This may be quite important in costing resources used in the construction phase of the project[60]. However, after the construction phase it is difficult to predict periods of unemployment, or even underemployment. This is particularly true of large public projects, since analysis of these are often conducted assuming project lives of up to 100 years. Attempts to predict unemployment over such periods may be misleading. In addition, Cost-Benefit analysis is concerned with the comparison of alternative projects. Consequently, for consistent appraisal and, hence, rational comparison of projects, it has been suggested that full employment be assumed over the life of the project, after the construction phase[61]. This has been the commonly used procedure.

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60. Haveman, R.H. and Krutilla, J.V. 1968. Unemployment, Idle Capacity and the Evaluation of Public Expenditures. Washington, D.C. Resource for the Future Inc., p. 91.

61. McKean. 1968, op. cit., p. 161.

(c) Taxation and Subsidies

Market prices often contain elements of indirect taxation, subsidies, or bounties. Indirect taxes will raise market price so that if it is used in valuation it will tend to overvalue the benefit of an output. Similarly, price support programmes, or bounties, will cause the market price to overvalue the benefit. On a strict interpretation of the Pareto criterion all benefits and costs should be valued net of taxes, subsidies, and bounties[62].

(d) Uncertainty

One of the major problems in the valuation of costs and benefits is uncertainty. Future costs and benefits should be considered in any Cost-Benefit analysis. Valuation of these future costs and benefits must involve prediction of future prices. Uncertainty increases with time and, consequently the accuracy with which future prices can be predicted declines with time. Hence, the economic life of a project must be limited, for purposes of evaluation, so that uncertainty does not become so great as to make reasonable estimates impossible.

There are a number of ways in which uncertainty can be considered in a Cost-Benefit analysis. One of these is by

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62. These are distributional items and do not affect economic efficiency. Therefore, they are not included in the analysis.

adjusting the economic life of the project[63]. Other methods[64] include the adjustment of estimates of various parameters to test their variation in different situations, or sensitivity analysis[65], and the addition of a risk factor to a riskless rate of discount.

4.5 SUMMARY

Ideally benefits and costs should be valued at willingness to pay and opportunity cost respectively. Valuation of benefits and costs of alternative projects according to these concepts will lead to a comparison of the alternatives in terms of the Pareto criterion. In a perfect market, market prices represent willingness to pay and opportunity cost of benefits and costs.

Problems may arise in valuation in perfectly competitive markets. The existence of external effects requires that such effects be included in the analysis, so that valuation at opportunity cost will represent the true social opportunity cost of resources. Similarly, difficulties arise in valuation,

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63. A summary of these attempts is given in Dasgupta and Pearce, op. cit., pp. 133-135.

64. Prest and Turvey, op. cit., p. 699. For a detailed description of the uncertainty problem see: Mishan, E. 1972, op. cit., pp. 268-296.

65. The use of sensitivity analysis is described briefly in Manual on Economic Development Projects, op. cit., pp. 138-142

if there are non-marginal changes in prices. This difficulty has not been entirely overcome. The valuation of the opportunity cost of project costs also poses a problem. This is because the precise value of the opportunity cost varies according to the source of funds. The 'second best' problem questions the validity of valuation at social opportunity cost, or shadow pricing. It suggests the need for a general equilibrium approach to valuation, rather than the partial equilibrium approach implicit in shadow pricing. However, the costs of using the general equilibrium approach may be greater than the benefits obtained.

Modifications often need to be made to market prices, derived from imperfectly competitive markets, to allow for imperfections. Such imperfections as imperfect competition, unemployment of resources, taxation and subsidies, and uncertainty cause market price and marginal cost to diverge. Consequently, market prices need to be modified to approximate willingness to pay and opportunity cost.

CHAPTER 5

THE ORD RIVER IRRIGATION PROJECT

5.1 INTRODUCTION

The Ord River Irrigation Scheme was undertaken, in 1963, as a precursor to more intensive development of Northern Australia. It was the first public project, in Australia, to be appraised using Cost-Benefit analysis. The scheme has raised issues concerning not only Northern Development, but also of efficient allocation of public funds in Australia. The controversy surrounding this scheme, in part caused the Federal Government to consider more closely the criteria for the allocation of public funds.[66] The scheme is, therefore, a useful example in the evaluation of Cost-Benefit analysis.

This chapter is intended to provide a general background to the Ord River Scheme.

5.2 GENERAL BACKGROUND

Specifically, the Order River Irrigation Project was undertaken as a joint venture by the State and Commonwealth Governments in an attempt to promote closer settlement of the East Kimberley

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66. "Investment Analysis", op. cit., pp. 5-28.

region of North Western Australia[67]. This was to be accomplished through developing intensive agriculture in the area.

The scheme involved constructing a main dam on the Ord River, with a diversion dam some thirty miles downstream to service an irrigation area of 30,000 acres. The diversion dam was to serve as a pilot scheme, the success of which would lead to the construction of the main dam. Construction of this dam would permit a total of 175,000 acres of land to be irrigated. This was completed in 1971.

Funds for the diversion dam were provided through the Western Australia Grant (Northern Development) Act, 1958-59. Further funds for the irrigation works were provided through the Western Australia (Northern Development) Agreement Act of 1963. Funds for the main dam were provided through the Western Australia Agreement (Ord River Irrigation) Act of 1968. Altogether, the total funds provided for the scheme amounted to approximately 65 million dollars, of which 30% were provided by the State Government.

The project is located in the extreme North of Western Australia and extends partly into the Northern Territory. This

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67. Kerr, A. 1967. Australia's North-West, University of Western Australia Press.

area is remote from the State's main centres of population, being roughly 2200 miles from Perth, and is separated from the arable lands of the South by a belt of some 1000 miles of semi-desert country. It is separated by even greater distances from most other major cities in Australia. Because of this isolation, transport costs are higher than for other areas of Australia.

The township of Kununurra was built at the scheme as a service centre in the hope that both farmers and farm labourers would live there. Wyndham, the closest port, is sixty miles away, and is connected to Kununurra by road. This port serves as the outlet for most of the products produced at the scheme. At the time of introduction of the project, it was serviced primarily by the State Shipping Service, and private lines interested in its rural exports. However, there was no regular shipping service.

5.3 AGRICULTURAL SYSTEM

Agriculture in the Kimberley region, prior to the inception of the Ord Scheme was primarily open range grazing of cattle[68]. This is still the major form of farming in the region. Grazing is

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68. For a detailed description, see Appendix I.

restricted almost entirely to native grasses and shrubs. Because of this, the nutrition of the stock is dependent, to a large extent, on the frequency of rains during the wet season and the lack of rain during the dry season. This results in problems in the poor quality of stock when marketed, and also in reduced calving rates. Consequently, farm income depends largely on seasonal conditions.

The introduction of irrigated agriculture into the region was hoped to reduce the effect of seasonal conditions and hence increase productivity. The tropical climate[69] of the Kimberley region limits the crops which can be grown successfully to tropical, or sub-tropical, crops. The long, dry winter is particularly advantageous for cotton growing and enables two crops per year to be grown. There are a large number of other crops which can, technically, be grown in the area. However, the profitability of growing many of these crops has been a major limitation. Safflower and rice were tried on a commercial basis, but were unsuccessful. At present, grain sorghum and cattle fodders have shown promise as economically profitable enterprises in the improvement of the quality and productivity of cattle from the surrounding pastoral areas.

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69. A detailed description of the physical environment of the Ord River region is given in Appendix II.

In the past, cotton has been the main crop grown in the area because of both the desirable physical conditions and the fact that demand has been greatest for this crop. However, rising farm costs and declining net incomes have reduced the profitability of cotton. At present, other crops are being tried, but beef lot-feeding appears to be the most profitable[70].

Total farm costs can be divided into on-farm costs, and off-farm costs. On-farm costs for cotton growing have been high, largely because of problems with weeds and pests which have built up through persistent cultivation. The problem with pests is crucial in the Ord region because of the number and variety of pests, their increasing resistance to certain insecticides, and the long growing season of the region[71]. Costs of pest control have been high because of the necessity for aerial application of insecticides during the wet-season. Similarly, weeds are harder to control at the Ord than in the southern growing areas, because of the heavy rains which usually follow planting.

Off-farm costs have also been high because of the location of the scheme. Its isolation has resulted in high transport costs, because of distance and lack of transport services. In addition, the weed problem has necessitated the use of more part-time

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70. "Ord Irrigation Project", op. cit., p. 11.

71. The Australian Cotton Growing Industry: An Economic Survey 1964/65 to 1966/67, Bureau of Agricultural Economics Australian Government Publishing Service, Canberra, 1971.

labour than is necessary in other areas of Australia. However, labour is scarce in this region, and consequently, labour costs are high. Since both labour and transport costs are high, total costs are higher than for southern regions.

5.4 RESEARCH

Because the Ord Scheme was established basically as a prelude to Northern development, it has been one of the most intensively studied projects in Australia. Consequently, there was a large amount of data about the region that could be used in an economic evaluation. The Kimberley Research Station has carried out most of this research.

The Research Station was established, in 1946, to look into the possibility of developing irrigated agriculture in the area. Early work concentrated on determining whether soils were suitable for irrigation, and whether a stable system of agriculture could be established, to provide a sound basis for settlement. Later work concentrated on finding the cash crops which would provide the best basis for settlement. This included conducting research programmes on crops such as cotton, oil seed, growing, pastures, cattle-feeding, sugar-cane and rice[72].

To gain information on yields and costs likely on a commercial basis, a pilot farm (2500 acres) was established

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72. "Ord Irrigation Project", op. cit., p. 6.

in 1959[73]. The operation of this farm, although not an unqualified success, revealed some of the problems of large-scale cropping of rice, linseed, safflower and cotton[74]. The cost data indicated cotton as the most profitable crop, with safflower and linseed as rotational crops. Further data was used in economic studies to determine the farm size most suited to a romal Australian farm system[75].

To provide for cropping for such a farm, and to allow for flexibility in farm size, the irrigated area was laid out in 220 acre units. Three such units were combined to form a farm. After allowing for area taken up by roads, drains, channels and buildings there was an area of roughly 600 acres for cropping[76].

5.5 THE CONTROVERSY

The first economic study of the Ord Scheme was a Benefit-Cost analysis conducted by the Commonwealth government[77].

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73. This was leased and run by a private company, Northern Developments Corporation.

74. "Ord Irrigation Project", loc. cit.

75. Defined as a farm consisting of an individual farmer plus either a son, or a permanent hired labourer.

76. "Ord Irrigation Project", op. cit., p. 7.

77. The Ord Irrigation Project: A Benefit-Cost Analysis, Bureau of Agricultural Economics, Commonwealth Government Printer, 1964

However, this was never published[78]. Davidson[79] was the first to publish an economic study of the Ord Scheme. This study indicated that the scheme was not justified on economic grounds. Following this Davidson published The Northern Myth[80], which criticised not only the Ord Scheme, but also Northern development in general. Davidson's studies were criticised primarily by Patterson[81] who conducted his own economic evaluation of the scheme using a different set of assumptions to those used by Davidson. Davidson's studies were also criticised by others[82]. However, the debate surrounding the primary benefits and costs of the scheme centred around Davidson's and Patterson's studies, and the relative assumptions they adopted in these studies.

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78. Parts of this study have been summarised in the publication Ord Irrigation Project: A Case for Financial Assistance from the Commonwealth Government to Complete the Ord Irrigation Project, Western Australian Government Printer, Feb. 1964.

79. Davidson, B.R.[1] 1964. "Economics of Irrigated Agriculture on the Ord River". Farm Policy, Vol. 3, No. 2, pp. 54-60.

80. Davidson, B.R.[2] 1965. The Northern Myth. Melbourne University Press.

81. Patterson, R.A. 1965. "The Economic Justification of the Ord River Irrigation Project". Australian New Zealand Association for the Advancement of Science, 38th Congress, Aug. 1965.

82. ... particularly Cannegieter, C.A.[1] 1964. "Economics of Irrigated Agriculture on the Ord River: A Note". Farm Policy, Vol. 3, No. 4, pp. 93-97.

The secondary benefits were evaluated by Cannegieter[83]. His studies were strongly criticised by Musgrave and Lewis[84], who attacked the secondary benefits he attributed to the scheme, and also the methods used to value them. Others[85] also contributed to the debate, but it mainly centred around Cannegieter, and Musgrave and Lewis.

The controversy and conflicting outcomes of the studies on the Ord highlight the confusion surrounding the use of Cost-Benefit analysis. The confusion arises not only over what benefits and costs to include in the analysis but also over the multiplicity of objectives, the appropriate criteria, and the means of valuation of the costs and benefits.

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83. There were three studies:

    (a) Cannegieter, C.A.[2] 1964. "The Secondary Benefits of the Ord River Scheme". Economic Society of Australia and New Zealand: W.A. Branch, Economic Studies No. 1, Economic Growth in Western Australia, p. 56.

    (b) Cannegieter, C.A.[3] 1964. "Some Socio-Economic Aspects of the Ord River Scheme". Economic Record, Vol. 40, No. 91, pp. 375-388.

    (c) Cannegieter, C.A.[4] 1965. "Comparison of the Ord Project with some Dutch River Basin Projects". Economic Activity in Western Australia, Vol. 8, No. 2, pp. 24-27.

84. Musgrave, W.F. and Lewis, J.N. 1965. "Measuring the Value of Political Arguments - A Comment on Cannegieter". The Economic Record, Vol. 41, No. 94, pp. 262-266.

85. (a) Bowen, I. 1965. "A Comment on the Ord Controversy". The Economic Record, June 1965.

    (b) Campbell, K.O. 1965. "Secondary Benefits - a Further Comment". The Economic Record, Sept. 1965.

CHAPTER 6

THE OBJECTIVES OF THE ORD RIVER PROJECT AND COST-BENEFIT ANALYSIS

6.1 INTRODUCTION

For a consistent comparison of alternative projects, objectives of the projects should be clearly defined and consistent. This is because, for cost-benefit analysis, a comparison of alternative development projects requires consistent comparison of the benefits and costs of alternative schemes, in terms of objective criteria. This can only be achieved if the objectives of the projects are both clearly defined and consistent.

The major objective of any development scheme would generally be maximisation of national welfare[86]. Economically, maximisation of national welfare involves maximisation of national income or output. A project would be regarded as economically efficient if it made some members of the communities better off, while making none worse off, in terms of income[87]. However, this assumes the current income distribution to be optimal. In

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86. Maas, A. et al., 1962. Design of Water Resource Systems: New Techniques for Relating Economic Objectives, Engineering Analysis, and Government Planning, London, Macmillan & Co. Ltd.

87. Ibid., p. 20.

addition, there may be social effects which must also be considered if national welfare is to be maximised.

Therefore, there may be three distinct overall objectives of any development project:

(i) Maximising national economic efficiency;

(ii) Maximising national welfare; and

(iii) Redistribution of income.

The objectives of the Ord Scheme can be grouped into these three overall objectives. However, only the objectives of maximising national economic efficiency and welfare can be evaluated by the criteria used in Cost-Benefit analysis.

6.2 EFFICIENCY AND WELFARE OBJECTIVES OF THE ORD SCHEME

The stated objective of the Ord Scheme was to promote closer settlement of the Kimberley region, through the establishment of irrigated agriculture in the area[88]. This stated objective involves many implied objectives which were not considered until after the inception of the scheme[89]. Such implied objectives include efficiency, welfare, and income redistribution objectives.

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88. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., p. 24.

89. See for example: Smyth, R.L. "The Ord River Irrigation Scheme". Economic Studies No. 1, Economic Growth in Western Australia, The Economic Society of Australia and New Zealand, W.A. Branch, Sept. 1964, p. 53.

The efficiency and welfare objectives are discussed below. These include those objectives implied in the establishment of irrigated agriculture and the improvement of the beef industry.

(a) The Establishment of Irrigated Agriculture

Irrigated agriculture was seen as a means by which to diversify the types of crops grown in Western Australia. Agriculture in the State was concentrated to a large extent on wheat and wool. It was hoped that by establishing irrigated agriculture in the Ord region, more tropical and sub-tropical crops could be grown. The production of such crops in Australia, at the time, was limited to sugar and cotton in Northern New South Wales and Queensland. There was a demand for these crops both in Australia, and overseas[90]. Therefore, establishment of such crops, in preference to other crops elsewhere in Australia, would affect the efficiency of the national economy. It was hoped that establishment of these crops at the Ord would contribute to national economic efficiency.

Research[91] prior to the inception of the scheme had indicated that, technically, a wide range of crops could be

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90. This was outlined in "Ord Irrigation Project: A Case for Financial Assistance", op. cit., pp. 34-36.

91. See Chapter 5.

grown in the area. Based on this, it was assumed that a number of different crops would be grown at the Ord, depending on the availability of both domestic and world markets. Growing such crops, in addition to sugar and cotton and in preference to growing other crops elsewhere in Australia, would also affect national economic efficiency.

A further implied objective affected the welfare of the nation but not economic efficiency. This objective involved the value of the Ord Scheme as a 'political argument' which would contribute to national defence[92]. There was considerable debate over the validity of this objective[93]. This debate was largely a result of the fact that the objectives of the scheme were never clearly stated. Therefore, such an objective, at the time, could logically be implied for the scheme, and just as logically, questioned. Consequently, lack of a clear statement of the objectives of a scheme may lead to difficulties in the definition of benefits.

(b) Improvement of the Beef Industry

A second implied efficiency objective concerned the possibility of by-products from Ord crops providing low-cost inputs for the cattle industry. The lack of adequate stock

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92. Cannegieter, op. cit., p. 56.

93. This is discussed in greater detail in Chapter 8.

management in addition to climatic difficulties, resulted in poor calving rates and a low quality of beef produced in the area. Irrigated farming was seen as a source of feed inputs for the cattle throughout the year. This would help improve both calving rates and the quality of beef marketed from the Ord region.

In addition, the Ord River Scheme was seen as a means to help eliminate soil erosion in the area[94]. The long, dry winter resulted in overgrazing during the winter months in most pastoral areas of the region. Such overgrazing has resulted in depletion of the natural vegetation. This, in turn, has resulted in soil erosion over a rather wide area of the region. The provision of alternative foodstuffs for the cattle during the dry season, in conjunction with a regeneration programme, was hoped to reduce, and eventually eliminate the problem. This would result in increased productivity in future years and, therefore, would contribute to national economic efficiency.

The fact that this objective was implied rather than stated has raised difficulties in deciding whether it is a

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94. This is outlined in Kerr, A.M. 1967. Australia's North-West, pp. 54-56.

primary or a secondary benefit. Since it was never clearly stated as an objective of the Ord Scheme it could be considered a spillover, or secondary benefit. However, if it was clearly stated as an objective it would have been defined as a primary benefit. Such lack of clarity in the definition of objectives may lead, therefore, to inconsistent appraisal and comparison of alternative project

6.3 INCOME REDISTRIBUTION OBJECTIVES

A number of income redistribution objectives of the scheme were also implied. These consisted of those objectives specific to Northern development, in addition to various State objectives.

(a) Northern Development

Irrigated agriculture was established to promote closer settlement of the Kimberley region. Implied in this was the use of the Ord Scheme as an initial step in the development of Northern Australia[95]. Several objectives have been outlined for developing Northern Australia through agriculture[96].

The first of these objectives was the necessity to increase population both for continued development of the region, and for defence. It was also hoped that development of the area would

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95. Smythe, op. cit., p. 53.

96. Prospects of Agriculture in the Northern Territory, Report of the Forster Committee, Commonwealth of Australia, Oct. 1960, pp. 9-11.

lead to an improvement in the welfare of the indigenous inhabitants, particularly the aboriginal population. A further objective outlined, for Northern Australia, was an increase in the value of production in the region.

It was hoped that if the Ord Scheme achieved these objectives, then more resources and wealth would be diverted to Northern development. Once again, because these objectives were implied there was a great deal of controversy over them.

(b) State Objectives

In addition to being part of Northern development, the scheme could also be considered as part of the overall development of Western Australia[97]. This included certain objectives, all of which would involve the redistribution of wealth, or income, to Western Australia by the Commonwealth Government, rather than to other States. Again these objectives were never clearly stated, but merely implied.

The first of these objectives was a consequence of the Federal system of public finance in Australia[98], and the concern

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97. The overall development plan for Western Australia at the time was outlined by Court, C.W. 1964. "The Development Programme in Western Australia. Economic Studies No. 1, Economic Growth in W.A. The Economic Society of Australia and New Zealand: W.A. Branch, Sept. 1964.

98. For a description of the Australian System of Public Finance see: Maxwell, J.A. 1967. Commonwealth-State Financial Relations in Australia, Melbourne University Press.

for Northern development at the time of inception of the scheme. Funds could be obtained by the State from the Commonwealth Government more readily for Northern development than for development of Southern areas. Because of this, it was hoped that the Ord Scheme would result in more funds being allocated to Western Australia for development[99]. A further implied objective of the State Government was the hope that the success of this scheme would result in the attraction of overseas and interstate capital into this State[100].

6.4 CONFLICTS BETWEEN OBJECTIVES

Even if the objectives are clearly stated, there may be conflicts between them, which can also lead to inconsistencies in appraisal and comparison. For example, an increase in the value of production at the Ord may be less than, and at the expense of, increased production elsewhere in the nation. Therefore, it may not be possible to increase the value of production at the Ord and maximise national economic efficiency simultaneously. Another conflict in objectives arises between

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99. Court, op. cit., pp. 63-64.

100. Developing the North: A Symposium, Australian National Economics and Commerce Students' Association, 5th Annual Convention, Perth, May 1966.

the increase in the population of the area and the maximisation of national economic efficiency. The adoption of the most profitable crop to be grown, such as cotton (a crop that should be grown on a large scale), may lead to maximisation of national efficiency, but not to intensive population increase.

These conflicts between objectives result in a lack of consistency in the appraisal and comparison of the projects particularly if there is a conflict between efficiency and welfare objectives. However, it would seem that in the case of the Ord Scheme most conflicts arise between efficiency and income redistribution objectives. Therefore the incorporation of both types of objectives into a Cost-Benefit analysis would necessitate the estimation of trade-offs between them to avoid inconsistency in appraisal.

6.5 SUMMARY

The lack of a clear statement of the objectives of the Ord Scheme resulted in difficulties in defining some benefits as primary or secondary. The increased output of the beef industry resulting from the scheme would have been regarded as a primary benefit if it had been clearly stated as an objective of the scheme. However, since it was only implied as an objective it would be considered a secondary benefit of the scheme. In

addition, the lack of a clear statement of the objectives, has led to confusion of such implied objectives as the "political argument" objective.

Even if there is a clear statement of objectives, where income redistribution objectives are important there may be conflict between the efficiency and the income redistribution objectives. Inclusion of income redistribution objectives in a cost-benefit analysis would require the need for trade-offs between these and efficiency objectives.

CHAPTER 7

PRIMARY BENEFITS AND COSTS OF THE ORD RIVER PROJECT

7.1 INTRODUCTION

Cost-Benefit analyses conducted on each of several alternative projects should result in equivalent ranking of alternatives. This equivalent ranking requires consistency in definition and valuation of both primary and secondary benefits and costs. Definition and valuation of the primary benefits and costsof the Ord River Scheme will be discussed in this Chapter.

7.2 DEFINITION OF PRIMARY BENEFITS AND COSTS

Most Cost-Benefit analyses conducted in Australia, including that on the Ord Scheme[101], have been concerned only with the primary benefits and costs of the scheme. In such studies BENEFITS were defined as direct net economic benefit, while COSTS were defined as the project costs[102]. Project costs can be determined using the data supplied by engineers.

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101. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., p. 24.

102. Ibid., loc. cit.

Consequently, most of the studies on the Ord River Project have been confined to consideration of the net economic benefit to irrigation farmers.

(a) Primary Benefits

The primary benefits of an irrigation scheme consist mainly of the increase in total gross revenue of the farmers involved in the scheme. The Ord River Scheme was a development project and, therefore, the primary benefits consist of the gross revenue the farmers obtain from the sale of cotton and other crops.

The increase in the gross revenue obtained by the beef industry as a result of the availability of low cost inputs from the Ord Scheme would be regarded as a secondary benefit[103]. The net revenue obtained by the sale of these low cost inputs by the farmers at the scheme would normally be regarded as a primary benefit. However, since the increased output of the beef industry resulting from the availability of these inputs is regarded as a secondary benefit, the revenue obtained from the sale of these inputs by the farmers at the scheme is merely a transfer from one sector to the other. It would, therefore, not be included in the analysis.

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103. This is discussed in Chapter 6.

Several engineering benefits were also outlined such as flood protection, silt control in the diversion dam, and the cessation of the need for pumping irrigation water to the farms[104]. Floods, in the past, have resulted in negligible damage to the area[105]. Therefore, the contribution of reduced flood damages to the primary benefits would be minimal. The two other benefits are benefits resulting from the building of the main dam only, and therefore would not be considered in a Cost-Benefit analysis of the whole scheme.

(b) Primary Costs

Primary costs comprise project costs and associated costs.

The project costs of the Ord River Scheme consist of the engineering costs, the costs of allied development works, and the costs incurred by government to assist in the establishment of farms.

The engineering costs include the costs of construction and operation of both dams, together with costs of associated irrigation works, such as channels and drains.

Cost of allied development works include, primarily, costs involved in construction and operation of the infrastructure

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104. Ibid., p. 33.

105. Public Works Department, Western Australia, Private Communication.

of Kununurra, particularly townsite development, school, hospital, roads, and various public amenities. In addition, it would comprise costs of construction and operation of service facilities, particularly in Kununurra, such as power supplies and sewerage. Any improvements in port facilities at Wyndham to accommodate extra production generated by the scheme would also need to be regarded as project costs of the scheme.

Although the Benefit-Cost analysis conducted on the scheme was never published, it was partially summarised in the publication "Ord River Irrigation Project: A Case for Financial Assistance"[106]. No other studies deal with these costs. Therefore, it is difficult to discern whether all these public costs were included in the evaluation of the scheme, particularly the operating costs of these facilities.

The government also incurred a large expenditure in assisting establishment of farms. This assistance consisted mainly of land preparation in clearing, ploughing, levelling, cultivating, and excavating irrigation and drainage ditches[107]. Such land preparation by the Government was carried out on the first 400 acres for the first nineteen farms and reduced to 250

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106. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., pp. 37-40.

107. "Ord Irrigation Project", op. cit., p. 7.

acres for subsequent farms[108]. This expenditure was to be recovered through mortgage repayments and is, therefore, considered a transfer payment, and not included in the analysis.

More assistance was given to farmers in the way of loans for land purchase, housing construction, and construction of the first cotton ginnery. However, these were repayable and could, therefore, be regarded as transfer payments. Difficulties do arise in the case of the first cotton ginnery, since the prearranged schedule of repayment has been continually deferred[109]. If repayment does not eventuate then this would be regarded as a project cost. A further project cost would be the income foregone by the beef industry as a result of the use of land for both dams, and the irrigation area[110].

Associated costs have been defined as those incurred in achieving the benefits. In the case of the Ord River Project, these would primarily be costs incurred in producing increased farm output. That is, they would include all fixed and variable farm costs. All rents and water charges would be regarded as transfer payments, and not included as farm costs.

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109. See Appendix II.

110. Sub-committee on Evaluation Standards, op. cit., p. 32.

Most primary costs are relatively easy to define. However, some difficulties may arise. For instance, in some Cost-Benefit analysis construction and maintenance costs of allied development works may have been excluded from the analysis. However, as they do represent costs incurred in the construction of the project, they should be included in the analysis. Most difficulties in defining primary costs arise in identifying transfer payments. These do not influence the efficiency or welfare criteria used in Cost-Benefit Analysis, and are, therefore, excluded from the analysis. For instance, if interest on the funds provided for the construction, operation and maintenance of the dams and irrigation works were repaid by the farmers, it would be regarded as a transfer payment. However, if such interest is not repaid then it must be regarded as a project cost of the scheme, since it would be an opportunity cost of the interest earned if these funds were invested elsewhere[111].

7.3 VALUATION OF PRIMARY BENEFITS AND COSTS

Few problems arose in the definition of primary costs and benefits of the Ord Scheme. However, a number of conflicts arose in the valuation of these costs and benefits. This was

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111. Davidson, B.R.[3] 1969. Australia Wet or Dry? Melbourne University Press, p. 73.

primarily because of the problem of uncertainty. Most conflicts arose in valuation of benefits and associated costs.

(a) Valuation of Project Costs

Project costs are valued at actual costs. The individual actual costs of various parts of the project are aggregated to give the actual project cost. This is adjusted to approximate opportunity costs by discounting with an appropriate rate of discount.

Because of uncertainty, most of these costs must be estimated. Construction costs are outlayed in the first few years of the project and, hence, can be reliably estimated. In addition, these costs can be estimated using engineering data. The reliability of such information, compared with the uncertainty of economic data, also helps reduce the uncertainty involved in the estimation of these costs.

The comparison between the estimated and actual costs plus further estimated costs on the scheme of the second stage of the scheme is illustrated in Table 7.1 below. The Table illustrates the reliability of such estimates.

Operation and maintenance costs are subject to more variation than construction costs[112] as they need to be

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112. Operation and Maintenance Costs of the Ord Scheme to date are given in Appendix IV.

TABLE 7.1

ACTUAL AND ESTIMATED COSTS OF THE SECOND STAGE OF THE ORD SCHEME

ITEM	COSTS ESTIMATED[1] IN 1964 ($)	ACTUAL COSTS TO 30TH JUNE 1971[2] ($)	FURTHER ESTIMATED COSTS[2] ($)	ACTUAL COSTS AND ESTIMATED COSTS FROM 1971 ($)
Main Dam	16,600,000	16,800,000	4,500,000	21,300,000
Channels and Drains to serve 120,000 acres	22,000,000	200,000	26,830,000	27,030,000
TOTAL	38,600,000	17,000,000	31,330,000	38,330,000

Source: 1. "Ord Irrigation Project: A Case for Financial Assistance from the Commonwealth Government to Complete the Ord Irrigation Project".

2. See Appendix IV.

estimated over the economic life of the project. This variation is largely due to uncertainty in estimating both the number of farms and town population. Growth curves of population must be estimated to predict the demand for various town services. Such growth curves can be reliably estimated for the first few years of the scheme. However, uncertainty increases with the number of years over which growth is estimated. Estimation of population growth depends largely on the profitability of farming at the scheme. However, human factors such as adaptation to the climate, and attitudes in general[113] may also influence population growth. Therefore, there is a great deal of uncertainty in the estimation of population growth.

Consequently, although construction costs can be estimated reliably, there may be considerable variation in estimates of operation and maintenance costs. Therefore, discrepancies may arise in the estimation of public costs in different Cost-Benefit analyses of the same project. This reduces the effectiveness of Cost-Benefit analysis in comparison of alternative projects[114].

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113. A survey has been conducted on such attitudes at Kununurra: Shaw, B. 1973. Transcience, Climatic Discomfort and Some Key Elements in Social Relations in Kununurra, a report extracted from a sociological research project carried out at Kununurra from 1970-72.

114. Means of overcoming this problem are discussed in Section 7.4.

(b) Valuation of Benefits and Associated Costs

Most studies[115] conducted on the Ord Scheme were concerned with valuation of primary benefits and associated costs. For an irrigation project such as the Ord Scheme, these effects are the increased farm output resulting from the scheme, and associated farm costs. Conflicts over valuation of farm output and farm costs have arisen mainly because of the problem of uncertainty. In order to value uncertain outcomes, assumptions need to be made concerning these outcomes.

Davidson[116] was the first to publish a study of the primary benefits and costs of the Ord River Scheme. In this study he compared the profitability of growing different crops[117], and different combinations of these crops at the Ord. He adopted assumptions about each of the following variables, in valuing these costs and benefits:

(i) Crop Yield

(ii) Expected prices of farm outputs

(iii) Expected production costs

(iv) Farm size.

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115. These studies were not actual cost-benefit analyses, but partial budgets and whole farm budgets of different crops, and combinations of these crops. They were, therefore, only part of a Cost-Benefit analysis.

116. Davidson, op. cit., pp. 54-60.

In addition, for Cost-Benefit analysis, assumptions need to be made concerning:

(v) The number of farms at the scheme each year over the economic life of the project; and

(vi) Economic life of the project and the appropriate rate of discount.

The following discussion will concern only assumptions adopted for cotton growing, as this has been the main crop grown at the Ord, and there is little commercial data available for other crops.

Crop Yield

Crop yield is an important determinant of farm output. Research at the scheme has indicated the average experimental yields of various crops.

Davidson[118] assumed average commercial yields would be 1450 pounds of seed cotton per acre. This is two-thirds of the average experimental yields. This assumption was derived from a study[119] in which commercial yields of various crops were compared with their experimental yields. The analysis revealed that, on average, the commercial yield was two-thirds of the experimental yield. Therefore, the assumption appeared to be based on solid grounds.

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118. Davidson, op. cit., p. 54.

119. Davidson, B.R.[4] 1962. "Crop Yields in Experiments and on Farms", Nature, Vol. 194, pp. 458-459.

However, this assumption was criticised by Patterson[120] and Cannegieter[121]. Patterson maintained that Davidson's data were out of date. However, a stronger criticism was levelled by Cannegieter who maintained that, over the economic life of the project, which would be anything up to 100 years, the highest current[122] experimental yields should be minimum indicators of average commercial yields.

Davidson refuted this argument, and maintained that it was relative yields that were of important consideration in Cost-Benefit Analysis[123]. Therefore, since yields elsewhere would increase, as well as yields at the scheme, there would be no significant variation in relative yields. Consequently, using estimates of commercial yields as two-thirds of the average experimental yields would be a more reliable indicator of relative yields than the maximum experimental yield.

However, since Cost-Benefit Analysis should be used to compare alternative projects, relative yields would be taken into consideration in this comparison. Consequently, it would seem logical to use an estimate of absolute commercial yields over a long period.

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120. Patterson, op. cit., pp. 22-23.

121. Cannegieter[1], op. cit., p. 93.

122. Current year = 1964.

123. Davidson, B.R.[5] 1965. "A Rejoinder", Farm Policy, Vol. 3, No. 4, p. 97.

Davidson's approximation for commercial yield was based on a comparison of commercial yields with experimental yields each year over a number of years[124]. It does not take into consideration that over a long period of time average commercial yield may increase with developing technology. In fact, for the development of a new area both commercial and maximum experimental yields may increase over a long period of time. The fact that average commercial yields of seed cotton have increased to a level equivalent to the experimental yields in 1964 is illustrated in Table 7.2, where average experimental yield in 1964 was 2200 pounds seed cotton per acre[125].

Table 7.2

Yearly Commercial Cotton Yield[1]

SEASON	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72
Lbs Seed Cotton/ Acre	1147	1961	2448	2343	2266	2629	2824	2987	2497
Lbs Lint/ Acre	372	636	794	760	735	853	916	966	810

Note: 1. See Appendix V.

124. Davidson[2], op. cit., p. 154.

125. Davidson[2], op. cit., pp. 159-160.

Therefore, Davidson's factor of two-thirds average experimental yield does not appear to be a reliable indicator of long-term commercial yields. A more reliable indicator would seem to be a factor relating future commercial yields to the maximum experimental yield attained at the time of appraisal. Such a factor would probably be subject to a large degree of inaccuracy, but would be a more logical method of estimating long-term commercial yields than current methods.

Use of absolute commercial yields estimated in such a way would, if the Cost-Benefit Analysis is used for comparison of projects, alleviate the need to be concerned with changing relative yields over time. However, this does not eliminate the problem of uncertainty, because of the large degree of inaccuracy involved in applying the factor proposed for estimating long-term commercial yields.

Expected Prices of Farm Outputs

The appropriate price for farm outputs would be the 'farm gate' price. This is the market price less transport and marketing costs.

Transport and marketing costs can be estimated reliably. Transport costs depend largely on the distance of the scheme from available markets. Because of the location of the Ord Scheme, transport costs are high compared to other cotton growing areas of Australia, although originally it was hoped that the proximity of the scheme to Asia would result in reduced transport

costs[126]. The high transport costs have also been due to the lack of shipping at Wyndham. With a larger output from the scheme, it is quite possible that more shipping would pass through Wyndham. This would reduce the marginal costs of shipping. It is quite possible, therefore, that transport costs could be reduced with increasing output from the scheme. Marketing costs for cotton consist largely of the costs to the farmer of ginning. Ginning costs are dependent on the size of output. Therefore, ginning costs, although high[127] since the inception of the scheme, could be reduced with increasing output from the scheme. Consequently, both transport costs and marketing costs are subject to uncertainty and, therefore, may lead to conflicting results.

Determination of market price requires estimating demands for outputs in available markets. For cotton this included both the domestic and export markets. There is a large degree of uncertainty in predicting future prices. Consequently there was disagreement about the appropriate market price that would be received for cotton. Disagreement about market price was

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126. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., pp. 34-35.

127. "The Australian Cotton Growing Industry: An Economic Survey, 1964/65 to 1966/67", op. cit., p. 50.

also centred on the issue of whether outputs should be valued at the subsidised domestic price, export price, or import parity price[128].

Davidson valued output at an export price of 14.944 cents per pound of seed cotton[129]. This assumption was criticised by Cannegieter on the premise that future economic development would not be so fast that the cotton produced at the Ord would not need to be marketed anywhere but in Australia[130]. He, therefore, maintained that the subsidised domestic price was appropriate in the valuation of output. He justified the use of subsidised price on the basis that other primary industries in Australia were subsidised and that their output were valued at the subsidised price.

However, the criterion considered in Cost-Benefit Analysis is the maximisation of national economic efficiency and welfare. Outputs from the scheme should, therefore, be valued according to their value to the national economy[131]. This would be the opportunity cost to the national economy of not producing this good. Under this criterion, therefore, subsidies represent transfer payments and are not part of the value of the output[132].

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128. See Appendix VI for a description of how these prices are determined.

129. Davidson[1], op. cit., p. 57.

130. Cannegieter[1], op. cit., p. 88.

131. Mishan, op. cit., p. 88.

132. The value of the cotton bounty alone, 1963/64 to 1971/72 was $3.37 million and, therefore, represents a significant proportion of primary benefits.

Therefore, if cotton was not produced in Australia it would need to be imported. This would involve the cost of the cotton on the world market, together with freight and transport costs. Consequently, any cotton produced at the Ord that is sold on the domestic market would be valued at import parity price. However, cotton sold on the export market would not involve inward transport costs and would, therefore, be valued at the export price.

This does not completely resolve the problem of conflicting results, as it still involves uncertainty in determining both domestic and world demands. However, it is apparent that outputs should be valued net of subsidies.

Expected Production Costs

Yields and price per unit of farm output have so far been discussed. Together, these determine gross income per acre. Net income per acre can be determined by subtracting the estimated production costs per acre.

Estimation of the expected production costs per acre may involve a large degree of uncertainty because of the number of components comprising this cost. Production costs can be estimated by determining the farm operations, and their timing, necessary for producing the crop. From this, it is possible to calculate the amount of labour and machinery necessary to produce a certain acreage of crop, and possibly the most

TABLE 7.3

COMPARISON OF ESTIMATED PRODUCTION COSTS

INPUT	PATTERSON'S ESTIMATE[1] ($/acre) 450 acres	PATTERSON'S ESTIMATE[1] ($/acre) 600 acres	DAVIDSON'S ESTIMATE[2] ($/acre) 1000 acres
Spraying and Defoliation	31.76	31.76	31.26
Fertilizer and Seed	25.34	29.7	12.32
Water	6.54	6.54	7.50
Fuel and Oil	3.56	3.56	4.74
Labour	14.24	15.9	37.74
Repairs and Maintenance	2.78	2.78	9.16
Other	1.56	1.34	-
TOTAL CASH COSTS	85.78	91.58	109.8
Depreciation	14.88	15.34	15.44
Operator's Allowance	11.10	10.0	4.00
Interest	9.86 (@ 6%)	8.80 (@ 6%)	7.08 (@ 5%)
TOTAL FIXED COSTS	35.84	33.14	26.52
TOTAL COSTS	129.82	121.62	136.32

1. Patterson, R.A. 1965. "Economic Justification of the Ord Irrigation Project".

2. Davidson, B.R. 1965. The Northern Myth, Melbourne University Press.

profitable system of farming. Therefore, production costs are determined primarily by the physical environment of the region, the system of farming, and the costs of the inputs. For instance, the long dry winter at the Ord enables two crops of cotton to be grown per year, but limits the harvesting period for rice to ten days[133].

Production costs consist of fixed costs and variable costs such as casual labour, fertilizer inputs, and insecticides[134]. Prices of all these inputs are not known with certainty and, therefore, must be estimated.

Davidson estimated the costs of production for a cotton crop on a 1000-acre farm. These are summarised in Table 7.3 Each item requires an assumption to be made about future prices. Discrepancies that arise because of different assumptions being adopted can be seen by comparing costs that are relatively independent of farm size such as repairs and maintenance. There is a discrepancy of $6.38 per acre in the cost estimated by Patterson and that by Davidson. This alone could result in a large divergence in the results of the different appraisals of the scheme.

A further conflict also arose over the use of subsidised prices in the valuation of costs. Fertilizer inputs have been

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133. Davidson[1], op. cit., p. 57.

134. Variable costs also include fuel, oil and grease, repairs and maintenance, defoliants, seed, depreciation and interest.

subsidised by the State Government[135]. These subsidies, once again, are transfer payments, and do not affect the efficiency or welfare criteria. Consequently, including these in the estimation of costs would result in underestimation of costs.

Farm Size

Net farm income can be determined using farm size and net farm income per acre. Optimal farm size may be determined using estimates of demand, and production costs. The effect of farm size on production costs per acre can be seen in Table 7.3. However, for Cost-Benefit analysis actual farm size is a more important variable than optimal farm size. This is because, to be of assistance in decision-making the analysis should indicate the uncertainty, or risk involved in the project. Consequently, assumptions need to be made about farm size.

Davidson assumed an optimal farm size of 1000 acres in his calculations. However, it was more generally accepted[136] that 600 acres was the appropriate farm size on which to base calculations of farm income. Once again, this variation would lead to discrepancies in calculations of net benefits of the scheme.

Number of Farms at the Scheme

The total primary benefit of the scheme net of associated costs can be determined from estimates of the number of farms at

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135. See Appendix II.

136. "Ord Irrigation Project", op. cit., p. 6.

the scheme and net farm income.

The number of farms at the scheme each year over the economic life of the scheme is difficult to determine. Generally, the number will grow from year to year. However, this depends largely on the success of the scheme, particularly in the early stages.

The Bureau of Agricultural Economics estimated that 214 farms would be developed over a period of 15 years[137]. The inaccuracy of this estimate is illustrated in Table 7.4, where it can be seen that at present, after nine years, there are only 20 farms at the scheme.

Table 7.4

Number of Farms at the Scheme and Area Sown to Cotton

YEAR	63/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72
Number of Growers	6	20	25	29	28	20	19	18	20
Mean Cotton Area per Grower (Acres)	254	271	326	393	409	419	370	500	487
Total Area Sown (Acres)	1524	5420	8150	11397	11452	8380	7030	9000	9740

Source: Public Works Department, Western Australia, Private Communication.

137. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., p. 24.

Growth curves for the number of farms at the scheme over its economic life would need to be estimated to determine total net primary benefits of the scheme throughout its economic life. As discussed earlier, this would be subject to a large degree of uncertainty. This growth curve would be largely related to the profitability of farming at the scheme. Consequently, profitability of farming is important in the determination of the net primary benefits of such a development scheme.

Economic Life and the Rate of Discount

Both the economic life of the project and the rate of discount have a great effect on the value of net benefits[138]. The choice of the appropriate rate of discount has already been discussed. The economic life is related to the rate of discount, since using a larger discount rate would result in a shorter economic life of the project.

Although ideally there is an appropriate rate of discount which represents social time preference, there is no justification for assuming that this time preference will remain the same in the future. Therefore, allowance must be made for uncertainty in the choice of discount rate and, hence, the economic life of the project.

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138. See: Duhs, A. 1969. "Economic Evaluation of Regional Development Schemes - A Study in Cost Benefit Analysis", CEDA, 'M' Series No. 22, May 1969.

7.4 ALLOWING FOR UNCERTAINTY IN COST-BENEFIT ANALYSIS

It appears that many difficulties and conflicts in valuation of primary costs and benefits arise from the need to make allowances for market imperfections. The most troublesome problem is uncertainty. Because of uncertainty, few appraisals of the same project will ever give identical results. This raises difficulties in the use of Cost-Benefit analysis for comparison of alternative projects.

Davidson made no allowance at all for uncertainty in any of his studies on the Ord Scheme. Consequently, if even one of his assumptions did not hold, the usefulness of the study for comparison with other projects would be reduced.

There have been a number of suggestions for allowing for uncertainty. Some of these were outlined earlier, including adjusting the economic life of the project to allow for risk, and adding a risk factor to a riskless rate of discount. However, although these methods do allow for risk they do not allow for uncertainty. That is, they do allow for greater costs but not for greater benefits in the future. Proposals such as Savage's Regret criterion, the Bayes-La Place criterion, and the maximin and minimax criteria[139] do allow for uncertainty, but are means

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139. Dasgupta and Pearce, op. cit., pp. 187-194.

for making a decision rather than means for aiding in decision-making. The purpose of Cost-Benefit analysis is to aid in deciding between alternative investment projects. Therefore, a means of allowing for uncertainty which aids in decision-making is required.

Sensitivity analysis is one such method. It involves using several estimates of uncertain variables in calculating net primary benefits. For instance, Patterson[140] calculated net returns to farms for four different yields, three farm sizes, four different levels of prices, and two levels of production cost.

Although this method can indicate to what degree net benefits will vary with changes in these variables, it is necessary to determine the appropriate range of variation. The two levels of production cost proposed by Patterson were derived, for different size farms, from the average production costs at the scheme in the two years prior to the analysis[141]. The high and low estimates proposed by Patterson are compared with the average farm cost per acre over the 1965/66 and 1966/67 seasons in Table 7.5

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140. Patterson, op. cit., pp. 16-17.

141. Ibid., p. 12.

Table 7.5

Sensitivity Analysis of Production Costs

ESTIMATE	PATTERSON'S ESTIMATED Low Estimate	High Estimates	ACTUAL COST[1]
COST ($/Acre)	121.62	149.24	179

1. Source: "An Assessment of the Income Situation of Cotton Growers", Bureau of Agricultural Economics, Occasional Paper No. 4, April 1971.

Table 7.5 illustrates that average costs over these two seasons were outside the range of costs Patterson proposed in his sensitivity analysis. It is possible that more detailed[142] estimation of the high and low estimates would lead to more reliable prediction of the possible range of production costs. However, it is apparent that for Cost-Benefit analysis to be of assistance in decision-making, subjective probabilities need to be imposed to determine the likely range of variation. This involves determining three estimates of the variable being considered[143]:

142. This would involve high and low estimates of each of the components of production cost, aggregated to give an overall high and low estimate of production cost.

143. Sensitivity analyses of this type are also known as "Triangular Distributions", and mean and variance can be estimated.

(i) the most-likely estimate;

(ii) a pessimistic estimate; and

(iii) an optimistic estimate.

Estimation of production costs involves consideration of a large number of production costs. Therefore, for greater consistency, the optimistic estimate of production costs, for instance, would be determined by aggregating the optimistic estimates of each of the costs to give production cost. A similar approach would be used with the pessimistic and most-likely estimates.

However, because many variables estimated in constructing a Cost-Benefit analysis are subject to uncertainty, most of these should be subjected to sensitivity analysis. This would result in a large quantity of data, which would reduce the value of Cost-Benefit analysis as an aid to decision-making. Cost-Benefit analysis would be a more useful aid if total variation of net benefits could be estimated and presented in the analysis. This would involve aggregating the probability distributions of all uncertain variables comprising the Cost-Benefit analysis.

There are two approaches to such aggregation[144]. The first involves aggregating estimated values into estimates of total mean and variance of the project. However, this approach is

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144. See: Reutlinger, Shlomo. 1970. "Techniques for Project Appraisal under Uncertainty", World Bank Staff, Occasional Papers, Number 10.

complicated by the existence of correlation between the various probability distributions[145]. A second approach which avoids this problem involves simulating a sample of outcomes based on randomly selected sets of observations from the probability distributions of inputs[146]. This approach does have a major problem in that the resulting estimates are appropriate to only one set of input distributions. However, it does appear to provide a means of allowing for uncertainty in Cost-Benefit analysis without detracting from its usefulness as an aid in decision-making.

7.5 SUMMARY

The primary costs and benefits of a public project are identified by the economic criteria in Cost-Benefit analysis. Therefore, they should be valued and defined in accordance with these criteria. The appropriate primary benefits and costs of the Ord River Scheme to be included in a Cost-Benefit analysis, together with the appropriate means of valuation, are summarised in Table 7.6.

These benefits and costs are aggregated to give the net benefit to cost ratio, discounted with the appropriate rate of discount. If this ratio is less than one, the project would

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145. Ibid., p. 132.

146. Such an approach has been developed in: Hertz, D.B. "Risk Analysis in Capital Investment", Harvard Business Review, Jan/Feb. 1964.

TABLE 7.6

DEFINITION AND VALUATION OF PRIMARY COSTS AND BENEFITS OF ORD RIVER SCHEME

	ITEMS	VALUATION
BENEFITS INCLUDED	Sale of Lint Cotton on Domestic Market	Import Parity Price
	Sale of Lint Cotton Export Market	Export Price
	Sale of Seed Cotton on Domestic Market	Import Parity Price
	Sale of Seed Cotton on Export Market	Export Price
	Sale of Other Crops on Domestic Market	Import Parity Price
	Sale of Other Crops on Export Market	Export Price
	Reduction of Flood Damages	Domestic Price
BENEFITS EXCLUDED	Revenue from Farm Outputs sold as Inputs to Beef Industry	
COSTS INCLUDED:		
(a) Project Costs	(1) Engineering Costs	Actual Cost. Discounted by Appropriate Rate of Interest.
	(a) Construction and Operation of Dams	
	(b) Construction and Maintenance of Associated Irrigation Works	
	(2) Cost of Allied Development Works Construction, Operation and Maintenance of:	(Depending on source of funds) = Opportunity Cost.
	(a) Infrastructure of Kununurra	
	(b) Service Facilities of Kununurra	
	(c) Port Facilities at Wyndham	
	(3) Non-Repayable Government Assistance	Opportunity Cost
	(4) Non-Repayable Interest on Construction, Operation and Maintenance of Dams and Irrigation Works	Opportunity Cost
	(5) Income Foregone by Beef Industry	
(b) Associated Costs	Costs of production of Farm Outputs at the Scheme	Opportunity Cost
COSTS EXCLUDED	Repayable Government Assistance to Farmers at Scheme	

not result in a Pareto improvement. If the ratio is greater than one, the project would result in a Pareto improvement. However, national economic efficiency and national welfare will only be maximised when the project with the greatest ratio, on comparison with other similar projects, is undertaken.

There are many problems in the definition and valuation of these primary costs and benefits. These problems arise because of market imperfections, particularly uncertainty. Such problems can be allowed for in the analysis, but do give rise to inconsistencies and contradictions in Cost-Benefit analyses of alternative projects. Despite this, primary costs and benefits are the most predictable and easily measured of the effects included in Cost-Benefit analysis.

CHAPTER 8

SECONDARY BENEFITS AND COSTS OF THE ORD RIVER PROJECT

8.1 INTRODUCTION

Most Cost-Benefit analyses conducted in Australia have considered secondary benefits and costs to be insignificant from a national viewpoint[147]. However, the generalised objective function of Cost-Benefit analysis is to maximise national welfare. Therefore, all benefits and costs which affect the welfare of a nation should be included in the analysis.

This chapter outlines some of the secondary benefits and costs of the Ord River Scheme. Some of the problems in definition and valuation of secondary benefits and costs are also discussed, together with possible means of overcoming these problems.

8.2 SECONDARY BENEFITS ORIGINALLY CONSIDERED FOR THE ORD SCHEME

Difficulties in defining the limits to secondary effects has resulted in confusion in defining the secondary benefits and costs to be included in Cost-Benefit analysis. This is illustrated by the controversy surrounding the secondary benefits

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147. Campbell, K.O. 1964. "Secondary Benefits", Economic Record, Vol. 40, pp. 597-598.

considered for the Ord Scheme. The secondary benefits of the Ord Scheme were considered originally by Cannegieter[148]. The benefits he considered were additional employment created by the scheme, additional income generated by the scheme and a "political argument" benefit.

(a) Additional Employment and Additional Income

The first secondary benefit considered by Cannegieter was additional employment opportunities created by the scheme. This was considered a secondary benefit on the contention that one of Australia's political objectives was large-scale immigration. By creating more employment opportunities the scheme would be encouraging more immigration into the country, thereby generating additional national income.

The second secondary benefit Cannegieter attributed to the scheme was the increase in income generated, in the Ord River region, by the scheme. He based this on the contention that the Ord was in "... an underpopulated area with undeveloped economic resources, and it is in the position that irrigation schemes will bring rapid development"[149].

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148. Cannegieter[2], op. cit., p. 56.

149. Ibid., loc. cit.

These benefits were disputed[150] on the basis that irrigation schemes in other undeveloped areas of Australia would generate a similar rise in income in the region concerned. Neither of these benefits is unique to the Ord region. For inconsistencies to be reduced in determining the secondary benefits and costs to be included in Cost-Benefit analysis, there should be a clear definition of secondary effects. Secondary effects are the effects on outputs of producers external to the scheme, and on the satisfactions of consumers. They are unique to the scheme. Neither additional employment, nor additional income, generated by the scheme would be included in a Cost-Benefit analysis under this definition.

(b) "Political Argument"

The third secondary benefit considered by Cannegieter was the "political argument" benefit. This was regarded as a benefit on the basis that large tracts of unoccupied, but usable, land in Northern Australia would induce aggression by overpopulated, neighbouring Asian countries. Cannegieter argued that development of areas of Northern Australia through schemes such as the Ord Scheme would reduce potential aggression.

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150. Musgrave, W.F. and Lewis, J.N., op. cit., pp. 265-266.

The scheme, therefore, would benefit the Australian nation by reducing its need for defence.

This benefit was disputed on the grounds that most Asian nations were not interested in Northern Australia[151], and that developing Northern Australia would encourage aggression by Asian nations rather than preventing it[152].

Inconsistencies may, therefore, arise in defining such an effect as a benefit or cost. Such inconsistencies may result in a large divergence between results of various Cost-Benefit analyses conducted on a project. Therefore, although such effects might need to be included in a Cost-Benefit analysis, they should be distinct from other secondary benefits and costs. This would allow for varying degrees of consistency possible in defining primary and secondary effects such as the "political argument" consideration.

8.3 SECONDARY BENEFITS AND COSTS THAT SHOULD BE CONSIDERED

It appears that none of the secondary benefits proposed by Cannegieter should be incorporated into Cost-Benefit analysis as secondary effects. In addition, he failed to estimate any

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151. Ibid., p. 263.

152. Campbell, K.O. 1962. "The Rural Development of Northern Australia". Australian Journal of Agricultural Economics, Vol. 6, No. 1, pp. 21-30.

of the secondary costs of the scheme, other than those costs incurred in producing the benefits.

The confusion over secondary benefits at the time was largely due to a lack of clear definition of the appropriate secondary effects to be included in Cost-Benefit analysis. The criteria used in Cost-Benefit analysis evaluate only those secondary benefits and costs that affect either the production possibilities of producers external to the scheme, but are unique to the scheme, or the satisfactions of consumers[153]. There are several consequences of the Ord Scheme which may be considered secondary benefits and costs in Cost-Benefit analysis.

(a) Increased Productivity of Beef Industry

The reasons for the increased productivity of the beef industry being considered as a secondary benefit, instead of a primary benefit, have already been discussed[154]. This secondary benefit is a result of the scheme affecting output of surrounding pastoral areas[155].

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153. See Chapter 3.

154. See Chapter 6.

155. Although the liberal use of DDT at the scheme does pose a problem, it appears to have had no discernable effect on the outputs of producers external to the scheme as yet. Consequently, it would not be included as a secondary effect.

A study[156] of the pastoral beef industry indicated several limitations to the efficiency of the industry.

These included:

(i) lack of control of the breeding cycle;

(ii) seasonal variation in pasture status; and

(iii) the absence of a store cattle market.

Control of the breeding cycle can be achieved largely through the fencing of the stations. The other two limitations can be reduced through the Ord Irrigation Scheme. The effects of seasonal variation in pasture status could be reduced through the provision of low-cost supplementary feeds during the dry season. The irrigated farms could also provide a store cattle market allowing for finishing feeding, thereby improving both the output and quality of beef.

There were several attempts at estimating this benefit at the time of the controversy over the scheme. The State Government[157] estimated the value of increased output to be $1,000,000 annually. Patterson[158] estimated an annual increase in net farm income of $10,630 for a herd size of 3,500 head. Although these estimates are subject to uncertainty, for which no allowance has been made, it appears that increased productivity

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156. Nunn, W.M. 1967. "Cattle and the Ord Irrigation Project". The Journal of Agriculture in Western Australia, Western Australian Department of Agriculture, Vol. 8, No. 10, Oct. 1967.

157. "Ord Irrigation Project: A Case for Financial Assistance", op. cit., pp. 32-33.

158. Patterson, op. cit., pp. 34-38.

of the beef industry would be quite a large benefit of the scheme. However, if this is included as a secondary benefit, the value of the low-cost inputs of the scheme would be regarded as transfer payments, and excluded from the analysis.

(b) Recreation

The Ord River area, prior to the inception of the irrigation project, was a relatively under-developed area. Consequently, there were few recreational facilities. The lack of such facilities, together with the distance of the region from the major cities, minimised recreational opportunities. The provision of such facilities since the building of the dam has been a real benefit to the people of this region.

Recreation is a benefit resulting from the effect of the scheme on the satisfactions of consumers. It is, therefore, a secondary benefit that can be evaluated by the criteria used in Cost-Benefit analysis.

In 1964, prior to the building of the main dam, recreational facilities included a concrete tennis court, a cricket club, fishing, swimming and the Ord River Club[159]. The construction of the main dam, in 1965, led to an increase in the population of permanent workers at Kununurra. Consequently, since 1965 there has been a vast improvement in the recreational opportunities

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159. Department of Development and Decentralisation, Western Australia, Private Communication.

available. These are illustrated in Table 8.1, together with estimates of the values of some of the facilities. These facilities are used by both the people at Kununurra and from surrounding pastoral districts, and have been financed by the people themselves. Consequently, recreation has been an important benefit of the scheme.

Table 8.1

Recreational Facilities since 1965

FACILITY	ESTIMATE OF VALUE[1] ($)
Four Tennis Courts	10,000
Basketball Club	2,000
9-Hole Golf Course	20,000
Race-Track - Annual Meeting	30,000
Pony Club	4,000
Pistol Club	-
Darts Association	-
Boat Club	40,000
Agricultural Society	-
Country Women's Association	-
Scouts and Guides	-
Penguin Club	-
Swimming and Fishing	-
Aero Club	-
Cricket Club	300
Football	-
Speedway	27,000

Source: Department of Development and Decentralisation, Western Australia, Personal Communication.

Note 1: These estimates are rough estimates only, to give an indication of the minimum value of these facilities to the community.

(c) Ecological Effects

In recent years the ecological effects of the Ord River Scheme have become of increasing concern. These are secondary effects of the scheme that may affect either the output of other producers, the satisfactions of consumers, or both. However, they are often slowly accruing and difficult to predict. Consequently, they may affect future generations, but are not considered by the present generation.

The Pareto criterion and the Compensation principle are the criteria used, in Cost-Benefit analysis, for evaluating effects of the project on the welfare of the nation. Both these criteria evaluate the welfare of the present generation only[160]. They do not consider the welfare of future generations. Therefore, ecological effects are, in the main, not evaluated by these criteria. However, those ecological effects that do affect the present generation should be considered under these criteria.

Some possible effects of the establishment of a man-made lake by the construction of the main dam at the Ord have been explored[161]. Some of those effects considered include the effect of the project on the populations of certain types of fish, and the introduction of diseases into the area.

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160. Dasgupta and Pearce, op. cit., p. 129.

161. This was a survey conducted as part of Operation Noah.

The establishment of the man-made lake was predicted to result in the reduction of certain fish that were valuable for mosquito control[162]. However, it was also predicted to result in an increase in the number of catfish, which are popular angling fish. Consequently, there were both benefits and costs predicted in the fish population as a result of the building of the main dam. However, these were only predicted and unless the whole ecological chain of events can be predicted, it would be difficult to determine whether all the benefits and costs had been considered. This could lead to biased results.

Most large-scale dams have attracted large numbers of water-birds[163]. These often carry with them diseases in one form or another. Studies of the Ord since the building of the main dam have found the vectors of three diseases not previously existing at the Ord. Cattle at the scheme are susceptible to all of these diseases and man to one of them[164]. However, it is difficult to predict whether such diseases will become established at the scheme[165].

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162. Mr R.J. McKay, Queensland Museum, Private Communication.

163. Stanley, N.F. 1972. "Ord River Ecology", Search, Australian New Zealand Association for the advancement of Science, Vol. 3, Nos. 1-2, Jan-Feb. 1972, p. 11.

164. F. hepatica, Fasciolisis, Paragonomiasis.

165. Western Australian Museum, Private Communication.

Therefore, although such ecological effects may be important, they are largely unpredictable even in the short run. Including such effects in Cost-Benefit analysis when it is not certain whether all interactions along the ecological chain of events have been predicted, may lead to biased results. In addition, the uncertainty may lead to conflicting results in different appraisals of the same project. Therefore, until it is possible to determine all the ecological costs and benefits of a scheme, it would seem desirable not to include such effects, in Cost-Benefit analysis, as tangible secondary effects. They would need to be considered in Cost-Benefit analysis, but distinct from both tangible and intangible secondary effects. Therefore, they could be included, with "political arguments", as indefinable secondary effects. They would be classed as indefinable secondary effects on the basis of the degree of inconsistency that would result from their inclusion in a Cost-Benefit analysis.

8.4 VALUATION OF INTANGIBLE COSTS AND BENEFITS

The intangible secondary effects, such as recreation, have generally been excluded from Cost-Benefit analysis in Australia, mainly because of difficulties in valuation[166]. However, if the

166. "Investment Analysis", op. cit., p. 16.

project is to be evaluated in terms of maximisation of national welfare, then such effects should be included in the analysis. Therefore, consistent evaluation of these effects needs to be attempted.

Benefits and costs should be valued at willingness to pay and opportunity cost respectively, to evaluate their effect on national welfare. There are several methods of measuring willingness to pay, including implicit evaluation by society, or analogy, and implicit evaluation by individual consumers, or use of demand curves[167].

Cannegieter used the analogy approach in valuing his proposed "political argument" benefit. This approach involved "... the attempt to correlate past managerial or political decisions into a systematic set of monetary values. These can then be applied to similar situations where no decision has been made"[168]. The sugar industry in Queensland was used as an analogy by Cannegieter in valuing his "political argument" benefit. This was used as an analogy because he maintained that it was promoted for many of the reasons which were being used to justify the Ord Scheme. Using this method, the "political

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167. Sinden, J.A., op. cit., pp. 7-12.

168. Ibid., p. 12.

argument" benefit was valued at $90 million.

Musgrave and Lewis criticised Cannegieter's approach to the valuation of this benefit because it ignored the relative sizes of the large Queensland sugar industry and the smaller Ord Scheme[169]. Therefore, the Queensland sugar industry would not serve as an appropriate analogy for the Ord Scheme.

In addition, they maintained that valuation of any benefit using analogous political decisions would not lead to consistent valuation of benefits, in that there may be inconsistency in such decisions. This view was supported by several studies which noted that past decisions are restricted to the range of possibilities considered and, therefore, the values obtained may not cover the range of current possibilities[170].

It would, therefore, seem that the valuation of intangible benefits using analogies may not lead to consistent valuations of a benefit, and do not necessarily represent willingness to pay for the current benefit, by society.

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169. Musgrave and Lewis, op. cit., pp. 264-265.

170. (a) Margolis, J. 1959. "The Economic Evaluation of Federal Water Resource Developments". American Economic Review, Vol. 49, No. 2, pp. 96-111.

(b) Hitch, C.J. and McKean, R.N. 1963. The Economics of Defence in the Nuclear Age, Harvard University Press, p. 422.

Measurement of willingness to pay using implicit evaluation by individual consumers may be used in the valuation of benefits such as recreation. It involves estimating willingness to pay through the determination of demand curves for the benefits. There are a large number of difficulties which need to be overcome in the estimation of demand curves for intangible benefits[171]. However, this appears to be a more consistent means of measuring willingness to pay than the use of analogies.

An intangible cost may be measured using its opportunity cost, which is the ratio of willingness to pay for alternative benefits. Consequently, many of the problems that exist in the estimation of willingness to pay also exist in the estimation of opportunity cost. A further difficulty is the determination of the appropriate benefits that need to be foregone[172].

Therefore, although intangible benefits and costs need to be evaluated in a Cost-Benefit analysis, there are many difficulties in valuing these effects. Consequently, consistent valuation may be difficult to achieve.

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171. These are summarised in: Sinden, op. cit., pp. 7-11.

172. Ibid., pp. 12-13.

8.5 INCOME REDISTRIBUTION EFFECTS

The criteria used in Cost-Benefit analysis do not evaluate income redistribution effects. Therefore, they are not included in the analysis. However, the redistribution of income to the Kimberley region was a major objective of the Ord Scheme. Consequently, for the Cost-Benefit analysis of such a project to be an aid in decision making, the effect of the project on the income of the region should, at least, be indicated.

This would involve considering the inter-relationships between all sectors of the economy of the region, and interactions with other regional economies[173]. Investment in any sector of an economy will result in a more than proportional increase in the income of that sector. Therefore, there is a multiplier effect. Consequently, estimation of the effect of investment on the income of a region would involve consideration of such "multipliers", in addition to the inter-relationships between the sectors of the regional economy.

There are several techniques available for estimating the effect of investment on the income of a region. These include

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173. Long, B.F. 1968. "Concepts and Theoretical Basis for Evaluation of Secondary Impacts", in Secondary Impacts of Public Investment in Natural Resources, United States Department of Agriculture, Miscellaneous Publication No. 1177.

economic base models, input-output analysis, and intersectional flows analysis[174]. These techniques involve different problems of estimation, and varying degrees of accuracy. However, it would seem that for purposes of evaluation, input-output analysis is the most useful[175].

Although input-output analysis can be used for indicating the effects of a project on the income of a region, there would be no need to estimate trade-offs between the efficiency, welfare, and income redistribution objectives of a project. Consequently, the estimation of income redistributional effects would be additional to the criteria in a Cost-Benefit analysis, rather than forming part of these criteria. This would enable a more meaningful comparison of alternative projects, given the multiplicity of objectives of each project, without contradicting the criteria used in Cost-Benefit analysis.

8.6 SUMMARY

In the past there has been confusion over which secondary benefits and costs to include in a Cost-Benefit analysis. The controversy over the secondary benefits Cannegieter attributed to the Ord Scheme illustrated that this confusion has arisen

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174. For a description of these see: McColl and Throsby, op. cit. pp. 10-16.

175. Ibid., pp.16-17.

mainly because of flow-on effects of the project on the economy. Such flow-on effects include additional employment and additional income generated by the scheme. Secondary effects have been defined as those that affect either the output of producers external to a scheme, or the satisfactions of consumers. They must be unique to that scheme. Flow-on effects are not unique to a particular project and should, therefore, not be included as secondary effects in the analysis.

Many secondary benefits and costs of a project may be intangible. The difficulties arising in valuation of these benefits and costs may result in inconsistencies in Cost-Benefit analysis of a project. Similarly, there may be effects which are difficult to define as benefits or costs. Such effects include "political arguments" for defence and ecological effects, given the present state of knowledge about ecological effects. These "indefinable" benefits and costs may cause even greater inconsistencies in the appraisal of a project. Therefore, there is a gradation of the degree to which the consistency of Cost-Benefit analysis would be affected by primary, secondary, intangible, and indefinable effects respectively The reliability of Cost-Benefit analysis required by the decision-maker would determine which effects should be included in the analysis. Some of the secondary effects which should have been included in, or excluded from Cost-Benefit analysis are

summarised in Table 8.2. The various secondary benefits and costs have been classified into tangible, intangible and indefinable effects.

Income redistribution effects of a project are not evaluated by the criteria used in Cost-Benefit analysis. However, where such effects are important to the project, Cost-Benefit analysis would be of greater assistance in decision-making if the direction and magnitude of these effects were, at least, indicated.

TABLE 8.2

DEFINITION OF SECONDARY EFFECTS OF ORD RIVER PROJECT

		ITEM	TANGIBLE	INTANGIBLE	INDEFINABLE
BENEFITS INCLUDED	(1)	Recreation		x	
	(2)	Increased Productivity of Beef Industry	x		
	(3)	Beneficial Ecological Effects to Present Generation			x
	(4)	"Political Argument"			x
BENEFITS EXCLUDED	(1)	Beneficial Ecological Effects to Future Generations			
	(2)	Additional employment			
	(3)	Income Redistributional Effects			
COSTS INCLUDED	(1)	Effects of Pollution (e.g. DDT) on Producers External to Scheme	x		
	(2)	Effects of Pollution on Consumers		x	
	(3)	Detrimental Ecological Effects on Present Generation			x
COSTS EXCLUDED	(1)	Detrimental Ecological Effects on Future Generations			
	(2)	Effects of Pollution on Producers at Scheme			

CHAPTER 9

CONCLUSION

9.1 SUMMARY AND CONCLUSIONS

This study has assessed Cost-Benefit analysis as a means of appraising rural development schemes, such as the Ord River Irrigation Scheme. It was assessed in terms of its value as an aid in deciding the allocation of funds between alternative rural development projects. Concepts associated with Cost-Benefit analysis were outlined, and Cost-Benefit analysis was defined.

The Pareto criterion and the Compensation principle were shown to be the appropriate social criteria for use in Cost-Benefit analysis. However, use of these criteria limited the scope of Cost-Benefit analysis to comparison of similar types of projects, such as alternative rural development projects. Similarly, it was shown that benefits and costs should be defined and valued in terms of these social and economic criteria. The appropriate valuation of benefits and costs, under these criteria, would be willingness to pay and opportunity cost respectively. In a perfectly competitive market prices are equivalent to willingness to pay and opportunity cost. However, in a perfectly competitive market, problems such as external

effects, the "second-best" theorem, and different sources of funds for project costs made valuation difficult. In imperfectly competitive markets, market imperfections such as imperfect competition, unemployment of resources, taxation and subsidies, and uncertainty resulted in the need for adjustments to market prices to approximate willingness to pay and opportunity cost.

The generalised objective function of Cost-Benefit analysis is maximum national economic efficiency, and maximum national welfare. Income redistribution objectives are not evaluated by either the economic or social criteria and are, therefore, not included in the objective function. Benefits and costs consist of primary and secondary effects. Primary effects are the direct effects of a project. Secondary effects are the effects of a project on the outputs of producers external to the project, and on the satisfactions of consumers. They must be directly attributable, and unique, to that project. Analytical criteria, such as net benefits, ratio of benefits to costs, and ratio of net benefits to costs, were outlined, in addition to investment criteria such as Net Present Value, and Internal Rate of Return. The appropriate criterion for use in Cost-Benefit analysis is the present value of the ratio of net benefits to costs.

Cost-Benefit analyses of alternative projects must be

consistent to be of assistance in deciding the allocation of funds between the projects. That is, if several Cost-Benefit analyses are conducted on each project, they would result in equivalent ranking of alternatives.

There was no clear statement of the objectives of the Ord River Scheme by Government. This resulted in difficulties in defining some benefits as primary or secondary. However, the objectives were implied in a statement, by Government, of the overall purpose of the scheme. These implied objectives were seen to comprise efficiency, welfare, and income redistribution objectives. The existence of income redistribution objectives resulted in conflicts between these and the efficiency objectives. Incorporation of efficiency and income redistribution objectives in Cost-Benefit analysis would require the need to quantify trade-offs between the two types of objectives.

Problems in definition of benefits and costs of the Ord River Scheme were in identification of transfer payments. These are distributional items and, therefore, should not be included in Cost-Benefit analysis. Most of the conflicts in the studies conducted on the Ord Scheme were over valuation of primary benefits and costs. It was shown that estimation of project costs although subject to some uncertainty could be reliably predicted. However, estimates of benefits and associated

costs were subject to a greater degree of uncertainty. Theoretical disputes, such as whether export prices or subsidised domestic prices are appropriate for valuation of farm outputs caused some of these conflicts. However, most conflicts arose because of the uncertainty problem.

Secondary benefits and costs have generally been excluded from Cost-Benefit analyses in Australia. However, secondary benefits were calculated for the Ord Scheme. These were additional employment and income generated by the scheme, and the "political argument" benefit. Both additional employment and income were flow-on effects and not unique to the Ord Scheme. Therefore, they should not have been included in Cost-Benefit analysis as secondary benefits of the scheme. It was possible to define the "political argument" as either a benefit or a cost. Inclusion of such a consideration in Cost-Benefit analysis would reduce its reliability as a means of comparing alternative projects. Therefore, such a "political argument" should be evaluated separately from other secondary effects.

Several secondary benefits and costs of the Ord Scheme that should have been included in a Cost-Benefit analysis were outlined These included the increased productivity of the beef industry, recreational benefits, and some ecological effects. Inclusion of each in Cost-Benefit analysis was seen to introduce varying

degrees of inconsistency into the analysis. Several classes of secondary effects were, therefore, suggested subject to the degree of inconsistency introduced into the analysis. These were tangible, intangible and indefinable secondary effects. Increased productivity of the beef industry would be a tangible, and recreation an intangible, secondary effect. "Political arguments" and ecological effects given the current state of knowledge, would be indefinable secondary effects.

Various methods of valuation of intangible benefits and costs were also outlined. While there are many problems in valuation of intangible benefits, the best available method was seen to be the use of demand curves, or implicit valuation by individual consumers. Intangible costs can be valued using opportunity costs.

9.2 RECOMMENDATIONS

There are many problems in appraising and comparing rural development schemes such as the Ord River Scheme. This section considers possible means of alleviating some of these problems.

(a) Definition and Valuation of Primary Costs and Benefits

One of the major problems in the definition and valuation of primary costs and benefits was uncertainty. Most inconsistencies in the studies on the Ord Scheme resulted from uncertainty.

Uncertainty in predicting future yields may be reduced by determining a relationship between current maximum experimental, and future commercial, yields. However, this would not fully overcome the problem of uncertainty. Most other variables comprising Cost-Benefit analysis are less predictable than yields.

Sensitivity analysis was proposed as a means of allowing for uncertainty, so that Cost-Benefit analysis would be of greater assistance in decision-making. However, since all uncertain variables in Cost-Benefit analysis should be subjected to sensitivity analysis, the accumulation of data would detract from the value of the analysis as an aid in decision-making. The presentation of a single estimate of the overall uncertainty of the project would enhance the value of Cost-Benefit analysis as an aid in decision-making. This would require the aggregation of the probability distributions of individual variables. Various methods are available for such aggregation. The single estimate of the overall uncertainty of the project would be presented in addition to sensitivity analyses of the individual variables.

(b) Secondary Benefits and Costs in Cost-Benefit Analysis

Secondary benefits and costs have, generally, been excluded from Cost-Benefit analysis in Australia. However, the generalised objective function of Cost-Benefit analysis includes the

maximisation of national welfare. If projects are to be appraised and compared in terms of this objective function, all costs and benefits that affect national welfare should be included in the analysis.

However, determination of primary benefits and costs gives an indication of the viability of the scheme. Viability is an important consideration for rural development projects such as the Ord Scheme. Consequently, such projects should be evaluated in terms of two sets of analytical criteria. This would involve estimating net benefit to cost ratios based on:

(i) primary benefits and costs;

(ii) primary, plus secondary, benefits and costs.

Secondary benefits and costs have been classified according to the degree of inconsistency they introduce into the analysis. If the degree of inconsistency is to be reflected in the analytical criteria, separate ratios should be estimated for each class of secondary effects. Therefore, overall, four sets of ratios should be estimated in Cost-Benefit analyses of projects such as the Ord Scheme based on:

(i) primary benefits and costs;

(ii) primary, plus tangible, secondary benefits and costs;

(iii) primary, plus tangible and intangible secondary benefits and costs;

(iv) primary, plus tangible, intangible and indefinable secondary benefits and costs.

The ratios to be considered would be determined by the decision-maker.

Income redistribution objectives are not included in Cost-Benefit analysis. However, they may be important objectives of rural development schemes, such as the Ord River Scheme. For Cost-Benefit analysis to be of greater assistance in deciding between alternative projects, such as the Ord River Scheme, the extent and direction of income redistribution effects should be indicated.

APPENDIX I

PHYSICAL ENVIRONMENT OF THE ORD RIVER REGION

A brief description of physical environment of the Ord River Region is given. The physical environment of the Kimberleys and in particular the Ord River Region has several unique features which are both advantageous and disadvantageous in certain aspects of agriculture in the area.

(a) CLIMATE[1]

The Ord Region has a normal southern tropical, monsoonal climate with a warm, dry winter and a hot, wet summer season. The average mean daily temperatures generally exceed $50^{o}F$, even during the coldest part of the year, while during the hottest part of the year they are in the region of $90^{o}F$. The area is completely frost-free. However, minimum temperatures below $50^{o}F$, during the winter months, may slow the growth of certain crops, particularly cotton. Mean annual rainfall is roughly 30 inches. It is virtually confined to the summer months. However, the length of the rainy season, the quantity of rainfall, and its distribution within summer months are variable. This can create considerable problems with drainage and cultivation in irrigated crops. The high mean relative humidity during the rainy season may be partly responsible for the high incidence

of diseases.

The long, dry winter season, coupled with the wet, humid summer season virtually limits the crops which can be grown successfully to tropical, or sub-tropical crops.

(b) SOILS AND TOPOGRAPHY[2]

The irrigable areas of the Ord River valley are primarily flat, alluvial plains covered almost uniformly with a heavy, cracking soil known as Cununurra clay. This soil has a low permeability which may lead to sporadic flooding and water-logging with heavy rains. The low friability of the clay makes it hard and difficult to work when dry, and plastic and sticky when wet. This makes mechanical operations impossible when it rains, increasing the difficulties of controlling weeds and insect pests. This clay is also low in nitrogen and phosphorous, making fertilizer application necessary.

There are small areas of loam soils which have much better characteristics than the clay. However, these areas are restricted.

(c) WEEDS[3] AND PESTS[4]

Agriculture on the Ord, to date, has been concerned primarily with cotton growing. One of the main problems has been weeds and pests built up through persistent cultivation.

Until 1960 the standard techniques for weed control were pre-irrigation followed by tillage and, where possible, inter-row cultivation. But these were not fully effective, particularly on long-cropped land. The most common weeds of upland crops, particularly cotton, were, and still are, pigweed (Trianthema Portulacastrum and Portulaca Oleracea), Chloris grass (Chloris barbata), and Awnless Barnyard grass (Echinochloa colonum). Weeds of other crops include Barnyard Grass (Echinochloa crus-galli), and during the wet-season nutgrass (Cyperus spp). In the dry-season satisfactory weed control can be achieved in irrigation channels and drains by delving and burning, but in the wet-season chemical control is needed.

The most serious pest of cotton has been Prodenia litura. It is active throughout the year, although activity declines considerably during the cooler weather of the dry season. This pest is very difficult to control with insecticides and resistance to chlorinated hydrocarbons has been built up over the years. Another serious pest for cotton crops has been the climbing cutworm (Heliothis Punctigera Wallengr) which is important because of its preference for the fruiting parts of the cotton plant. Some of the other more important pests include the Rough Bollwom (Erias huegeli Rog.) the spotted Bollworm (Erias Fabia (Stoll)), the Pink Bollworm (Pectinoplora

Gossypiella), and the Cotton Looper (Anomis planalis). Control to date, has been achieved through the use of chemicals, mainly DDT and Parathion. Aerial application has been necessary in commercial areas, as it has been virtually impossible to carry out a regular spray programme with ground equipment during the wet season due to the boggy ground and the time involved.

Sources:

1. Ord Irrigation Project, Public Works Department, Western Australia, Aug. 1972.

2. Basinski, J.J. 1963. Cotton Growing Industry in Australia: An Economic Survey (C.S.I.R.O. Publication).

3. Van Rijn, P.J. 1965. "Weeds and Weed Control". Journal of Agriculture, Vol. 6, No. 5, pp. 311-312.

4. Richards, K.T. 1964. "Insect Pests of Cotton in the Ord River Irrigation Area". Journal of Agriculture, Vol. 5, No. 2.

APPENDIX II

STATE GOVERNMENT ASSISTANCE

The State has given the Ord farmers both direct and indirect assistance:

(A) INDIRECT ASSISTANCE

This has two components:

(1) Deferment of the rental on the No. Ginnery owned by the Government and leased to the Co-operative.

These rentals, which are on a decreasing scale, have been deferred for a six-year period. The Co-operative will utlimately make full repayment.

(2) The State has met the Co-operative's loan repayments on the No. 2 Ginnery due since 1969.

This assistance is repayable and is secured by a deventure.

(B) DIRECT ASSISTANCE

This has consisted of a subsidy of approximately 1.7 cents per pound of lint since 1969. For the 1972 and 1973 seasons an additional incentive subsidy to encourage farmers to produce high grade cotton has been made available.

The State Assistance to farmers is summarised in the following table:

YEAR	STATE ASSISTANCE	TOTAL VALUE ($)
1968	Rental Holiday No. 1 (payment deferred)	53,465
	Reduction in Power Charges (estimate)	25,000
	TOTAL	78,465
1969	2 cents subsidy based on 1968 production	72,656
	Rental holiday No. 1 gin (payment deferred)	51,621
	Reduction in Power Charges (estimate)	25,000
	Capital repayments (construction of No. 2 Gin and Improvements to No. 1 Gin)	85,500
	1.798 cents subsidy to growers on 1969 production	127,891
	TOTAL	362,668
1970	Rental holiday No. 1 gin (Payment deferred)	49,776
	Capital Repayments (construction of No. 2 Gin and Improvements to No. 1 Gin)	85,500
	1.7 cents subsidy	112,522
	TOTAL	247,798
1971	Rental holiday No. 1 Gin (Payment deferred)	47,931
	Capital Repayments (construction of No. 2 Gin and Improvements to No. 1 Gin)	54,992
	1.7 cents subsidy (estimate)	146,191
	TOTAL	249,114
1972	Rental holiday No. 1 Gin (Payment deferred)	46,086
	Capital Repayments No. 2 Gin	46,732
	Subsidy on Lint	161,250
	TOTAL	254,068

Source: Public Works Department, Western Australia, Private Communication.

APPENDIX III

CAPITAL EXPENDITURE ON THE ORD RIVER SCHEME TO 1971

ITEM	TOTAL ITEM COSTS ($ million)	TOTAL COSTS ($ million)
Stage 1. Works		
Irrigation Scheme - dams, channels, etc.	15.5	
Development of Farms, Stage 1	0.7	
Cotton Ginnery	0.6	
TOTAL - STAGE 1		16.8
Stage 2. Works		
Main Dam	16.8	
Irrigation Channels, etc.	0.2	
TOTAL - STAGE 2		17.0
Services		
Electricity Supply	1.5	
Kununurra Water Supply	0.5	
Kununurra Sewerage Scheme	0.3	
TOTAL		2.3
Infrastructure		
Kununurra Townsite Development	2.0	
Main Roads Department	0.7	
Kununurra Airport - Jet Strip	0.7	
Public Buildings, School, Hospital	0.7	
TOTAL		4.1
Minor Works not Classified		0.3
OVERALL TOTAL		40.5

Source: Public Works Department, Western Australia, Private Communication.

APPENDIX IV

OPERATION AND MAINTENANCE COSTS OF THE ORD SCHEME

SERVICE	1963/64 to 1966/67 ($'000)	1967/68 ($'000)	1968/69 ($'000)	1969/70 ($'000)	1970/71 ($'000)	1971/72 ($'000)	1963/64 to 1971/72 ($'000)
Irrigation	745.3	305.6	633.7	757.9	797.6	518.5	3758.6
Water Supply	113.5	48.0	54.8	59.0	81.6	48.7	405.6
Electricity	164.1	20.9	42.9	35.7	25.6	N.A.	N.A.
Caravan Park	21.5	10.6	7.4	-	-	N.A.	N.A.
Hostel	119.8	47.0	57.0	78.4	76.6	176.5	555.3
Sewerage Scheme	-	-	-	14.3	28.0	8.9	51.2
SUB-TOTAL	1164.2	432.1	795.5	945.3	1009.4	N.A.	N.A.
AIRPORT	27.7	9.1	17.7	28.1	N.A.	41.0	N.A.
TOTAL	1191.9	441.2	813.5	973.4	N.A.	N.A.	N.A.

Source: Public Works Department, Western Australia, Private Communication.

APPENDIX V

SUMMARY OF COTTON PRODUCTION AT THE ORD RIVER SCHEME, 1960/61 TO 1971/72

YEAR	TOTAL AREA OF CROPS IRRIGATED (ACRES)	AREA OF COTTON IRRIGATED (ACRES)	NO. OF GROWERS	MEAN COTTON AREA PER GROWER (ACRES)	YIELD (LBS LINT/ ACRE)	YIELD (LBS COTTON SEED/ ACRE)	AVERAGE COTTON BOUNTY (¢/LB OF LINT)	TOTAL COTTON BOUNTY ($)
1960/61	167	7						
1961/62	630	30						
1962/63	219	192						
1963/64	3429	1748	6	254	372	1147	14	91,036
1964/65	7115	5519	20	271	636	1961	13.2	463,320
1965/66	11651	8403	25	326	794	2448	9	394,388
1966/67	12088	11806	29	393	760	2343	9.2	587,538
1967/68	13688	11800	28	409	735	2266	5.6	485,935
1968/69	10142	8371	20	419	853	2630	5.7	573,716
1969/70	9497	7123	19	370	916	2824	5	383,392
1970/71	11797	8974	18	500	966	2978	4.5	390,100
1971/72	13264	9752	20	487	810	2497	Nil	Nil
1972/73	14000	8444						

Source: Public Works Department, Western Australia, Private Communication.

APPENDIX VI

DETERMINATION OF EXPORT, IMPORT PARITY AND DOMESTIC PRICES OF COTTON AT THE ORD SCHEME

(A) EXPORT PRICE

(1)	LintPrice f.o.b. Wyndham	= World Price for 'X' Quality Cotton + Premium for Quality - Freight Differential.
(2)	Lint Price at Farm Gate	= Lint Price f.o.b. Wyndham - Freight and Handling (Ginnery to Wyndham) - Ginning and Marketing Cost.
(3)	Price for Seed Cotton Equivalent	= Lint Price at Farm Gate x Conversion Factor.

(B) IMPORT PARITY PRICE

(1)	Import Parity Price for 'X' Quality Cotton at Spinners Stores	= World Price for 'X' Quality Cotton - Freight - Charges to Spinners Stores.
(2)	Price at Spinners	= Import Parity Price for 'X' Quality Cotton - Premium Price for Quality.
(3)	Lint Price at Farm Gate	= Price at Spinners - Freight Costs - Ginning and Marketing Costs.

(4)	Price for Seed Cotton Equivalent	= Lint Price at Farm Gate x Conversion Factor.

(C) DOMESTIC PRICE

(1)	Lint Price at Spinners	= Import Parity Price for 'X' Quality Cotton + Bounty Payment + Premium Payment for Quality.
(2)	Lint Price at Farm Gate	= Lint Price at Spinners - Freight Costs - Ginning and Marketing Costs
(3)	Price for Seed Cotton Equivalent	= Lint Price at Farm Gate x Conversion Factor.

SOURCE: Patterson, R.A. 1965. "The Economic Justification of the Ord Irrigation Project". Australian New Zealand Association for the Advancement of Science, 38th Congress Aug. 1965.

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