

THE ECONOMIC EVALUATION OF INVESTMENT IN LARGE-SCALE
PROJECTS - AN ESSAY TO RECOMMEND PROCEDURES

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The task of assembling recommendations on the use of project evaluation procedures has been attempted previously. For example, the "Green-Book" has laid a long-respected basis for evaluation work; more recently documents from the United States Senate have emerged as valuable standard references.

Discussions continue at academic levels on both theoretical aspects and the application of discounted flow techniques. In recent years the limitations of discounted flow techniques have been recognised and emphasised, and amid the volumes of literature on this subject there has not appeared, to my knowledge, a simple statement of recommended practices and standards which will materially assist those whose interests lie only in the empirical side of discounted flow techniques. Our experience at Lincoln and the discussions of the Seminar recently completed have forced a realisation of the difficulties facing many who are expected to provide economic information on proposed projects. The diversity of background of those whose duties include economic evaluation indicates that few have been exposed to "professional training" in discounted flow techniques and that they gain small comfort from books and professional journals.

Obviously the lack of a series of uncomplicated recommendations for use at "grass-roots" level exists because it would be considered professionally naive to publish them, even though a writer may have established them subjectively for his own work. In the interests of uniformity, I intend then to be naive, to provide some recommendations which I believe would not be frowned upon too heavily by both respected practitioners and academics, and which probably represent the consensus of informed opinion. No theoretical justification is offered in support, since this would presuppose familiarity

* This paper was prepared consequent to, and at the request of, the Seminar on Project Evaluation. It contains some material already mentioned in the papers earlier in this book, and has benefited from the discussions of the Water Resources, Land Development, and Forestry/Land Development workshops of the Seminar. The contributions by the discussants of these workshops is gratefully acknowledged, also the advice received by Mr R.W.M. Johnson, Professor J.G. Yoho, Mr A.C. Norton, Mr A.C. Lewis and Mr H.J. Plunkett on earlier drafts; all responsibility however lies with the author.

with the theory by many who have not seen the literature, and would complicate unnecessarily a paper which is meant to be free of academic complexities. I fully realise that many may disagree with some of my recommendations, but submit this paper as an interim guideline, until a better one is produced. And this will be welcome. In the meantime, the Agricultural Economics Research Unit at Lincoln College will be guided by these standards for evaluation work commenced in 1968 and later.

The recommendations in this essay refer to the evaluation of large-scale projects - defined for our purposes as projects initiated above the level of the firm; from irrigation projects to reservoirs and so on. The wide range of projects which possibly fit into this category means that detail is impossible in a paper of this nature. The essay considers primarily evaluation procedures in the New Zealand agricultural scene¹, and is limited to established discounted flow techniques. A working knowledge of these techniques is assumed.

The following topics are dealt with:

1. Objective of the Investigation
2. Scope of the Project
3. Viewpoint
4. Terminology
5. Representation of Benefits & Costs
6. Period of Analysis
7. Discount Rate
8. Index of Overseas Exchange
9. Output Prices
10. Sensitivity Analysis
11. Double-counting
12. Presentation of Results
13. Expected values
14. Re-appraisal
15. Investment & Financing
16. Policy Conclusions.

1. Objective of the Investigation

It is desirable that economic reports be preceded by a clear statement which provides perspective on the evaluation and the reason for the study. This statement should specify the economic facts it is hoped to demonstrate, and the particular decision-making situation to which these facts are appropriate, e.g. - some reports are prepared primarily as

1. It should be stressed that the application of discounted flow techniques in "non-agricultural" investment evaluation has been successfully practiced for several years. This essay however, avoids discussion of all but agricultural applications.

methodological demonstrations, others are empirically oriented using established methods; some are basically "research" reports intended for example to demonstrate desirable or undesirable directions of development, others may be intended directly as guides to individual cash investment decisions.

The specific aim of the project should be outlined. For example, one or more of the following may be intended:-

- (a) to provide information for an accept-reject decision on a particular project,
- (b) to compare two or more alternative projects,
- (c) to calculate the maximum investment advisable to achieve specific benefits,
- (d) to compare different rates or timing of investment.

The prime consideration for specifying the aim of the study should be the question posed to the practitioner, remembering that discounted flow techniques are reasonably flexible and that a slavish adherence to the "usual" procedures of calculations may not produce results in a satisfactory form. If possible the political and social framework within which the decision is to be made should be outlined, as well as the flexibility available to the practitioner in terms of the scale of the project.

2. Scope of the Project

A precise description of the project(s) should be provided. Physical boundaries should be defined along with sufficient technical information to enlighten but not confuse the uninitiated. Technical information may be valuable to later workers in the same area, and if this is likely, it is better retained in an appendix than lost to posterity. Simple maps of project location and boundaries of influence could be included. It is important to signify the relative size of the project and whether or not externalities are likely to be important, and the direction of their influence, even if their effect is not included in later calculations. Any technically limiting factors should be recognised.

3. Viewpoint

Analysis should define and state the viewpoint from which the study is executed.

- (a) National viewpoint. The effects of project establishment should in the case of large-scale projects, be traced as far as possible throughout the economy, and will include benefits and costs accruing to the nation as a whole. These are usually evaluated through effects on national income. In the case of

large-scale projects which involve overseas sales and purchases the national viewpoint should include consideration of the net effect of the project for overseas exchange. Adequate evaluation of smaller projects, e.g. drainage schemes involving a limited number of farmers can undoubtedly be carried out from the national viewpoint without the inclusion of "spillover" or exchange benefits.

- (b) Regional or District viewpoints. These studies include the effects of the project on regional or district populations and local governments.
- (c) Industry viewpoint. The effect on an industry, through both pricing and production, of the establishment of a project.
- (d) Individual viewpoint. The effect of a project on an individual firm, its operation and profits.

Other viewpoints should be recognised if necessary. Projects which could involve public money are correctly evaluated from the national point of view. Studies of farm development are useful from the national point of view only if some policy suggestions are possible and are given.

It will readily be recognised that some effects of a project may be benefits from one point of view and costs from another, and vice versa. Further, some policy questions, e.g. a desirable level of public subsidy, can frequently be answered only if evaluation is attempted from more than one point of view.

4. Terminology²

Benefits are defined as the increases or gains in the value of goods and services which result from conditions with the project, as compared to conditions without the project. Benefits should be measured net of indirect and direct costs, and include both tangible and intangible benefits. They may be classed as primary or secondary.

Tangible Benefits - those which can be expressed in money terms.

Intangible Benefits - those which are not fully measurable in money terms, or may not be satisfactorily expressed in money terms, in formal analysis.

Primary (or Direct) Benefits - the value of goods and services directly resulting from the project less direct and indirect costs incurred in realisation of the benefits.

2. The definitions of Benefits and Costs are modified and condensed from my earlier paper. (Paper 4.)

Secondary (or Indirect) Benefits and Spillovers - the increase in the value of goods and services which indirectly result from the project under the conditions expected to occur with the project as compared to those without the project. Secondary benefits and spillovers are measured net of any costs which have to be incurred to realise them.

The simplest solution to the common imprecision of definition of these terms is that spillovers should be acknowledged when a study takes the national point of view, and that secondary benefits occur locally and should be recognised in studies when a local or regional viewpoint is taken.

Costs

Direct Costs - includes the value of goods and services used in constructing, operating and maintaining the project. This category of costs includes all other identifiable expenses, losses, liabilities and indirect adverse effects connected with the project, whether or not compensation is involved, whether tangible or intangible. Costs of investigation, both technical and economic, should be estimated and recorded separately as a cost of the decision making process, but not included in the analysis.

Indirect Costs - the value of goods and services over and above those included in direct costs needed to make the immediate products or services of the project available for use or sale.

Overseas Exchange Benefits & Costs

The net requirement or contribution of a project to overseas exchange is appropriate to evaluation of large projects in the New Zealand economy. Some index of the premium on overseas exchange (at f.o.b. prices) should be applied as a measure of the net social benefits or costs from this source. These benefits could be both primary and secondary and both tangible and intangible.

The terms benefits and costs should be seen as terms which specifically include non-cash allowances. Where these are not included in the study, the terms "benefits" and "costs" are inappropriate. At least four situations, with specific terms describing the flows, can be distinguished:-³

- (a) Individual Viewpoint - Cash Flow Studies - where cash flows only are considered, and the net cash flows are required;

3. Notation used is that outlined in my earlier paper. (Paper 4.)

- b_j = receipts or expected receipts
 c_j = payments or expected payments
 V = present value of receipts
 C = present value of payments
 $V-C$ = net present value (or private net present value)
of project.

This case is similar in effect to the discounted cash flow (D.C.F.) method commonly used by accountants.

(b) Individual Viewpoint - Including Depreciation or Renewal Funds, or other Non-Cash Allowances

- b_j = income or expected income
 c_j = expenditure or expected expenditure
 V = present value (worth) of income
 C = present value (worth) of expenditure
 $V-C$ = (private) net present value, or (private) present worth of project.

(c) Large Scale Projects - Cash Flow Studies Expected cash flows only, from a regional, industry or national viewpoint, and would include usually only primary benefits with direct and indirect costs:

- b_j = returns or expected returns
 c_j = costs or expected costs
 V = present value of returns
 C = present value of costs
 $V-C$ = (social) present worth or (social) present value of project.

(d) Large Scale Projects - Including Non-Cash Allowances Both primary and secondary benefits are included, perhaps with some values imputed or simulated, and with allowances for other factors such as net requirement of overseas exchange:-

- b_j = benefits or expected benefits
 c_j = costs or expected costs
 V = present value of benefits
 C = present value of costs
 $V-C$ = (social) present worth or project.

5. Representation of Benefits and Costs (Income, Expenditure, etc.)

Benefits and costs included in the calculations should be clearly listed and the method of calculation described - preferably in reasonable detail, in an appendix.

All foreseeable consequences of a project should be taken into consideration. However, the limitations of our techniques demand that the benefits and costs be represented in money terms if they are to enter an economic evaluation. The first problem then is to devise the most satisfactory way of representing the various classes of benefits and costs in money terms.

In large scale projects a broad spectrum of benefits exists - from actual money benefits to intangible benefits. Actual cash flows present no problems of measurement. Similarly, intangibles, by definition, cannot be included in the discount analysis. An indication should be given however of the nature of the intangibles - whether qualitative or quantitative, political or social - and the section of the community likely to be affected. Where the reason is not obvious the classification of a benefit or cost as intangible should be justified by listing the reasons for avoiding measurement.

Between these extremes are benefits which can be represented in money terms with varying degrees of accuracy, comfort and effort.

The synthesis of expected cash flows from both expected technical coefficients (e.g. yields per acre) and expected price and cost figures, is often necessary. The matter of forward estimates of prices for use in the calculation of cash flows is considered later. Preceding papers will have made it clear that small variations in the magnitude and sequence of cash flows may have an alarming influence on the criteria developed for decision making. Every effort must be made to represent expected cash flows as faithfully and as objectively as possible. The following points might aid in this objective:-

- (a) Estimates of technical coefficients should aim at accuracy, and the tendency to "play safe" by deliberately incorporating conservative estimates should be avoided. Most estimates of future

production, particularly in the long term, are uncomfortably subjective; using conservative figures does not eliminate or minimise error, but probably ensures its existence.

- (b) Technical change is characteristic of the agricultural sector, and therefore its incorporation in the synthesis of cash flows is highly desirable if the period of analysis is more than 5 or 10 years. Discounted cash flows would normally compare the "with" and "without" situations; the "without" situation is often mistakenly assumed to be a "status quo" situation. Technical change is an integral part of both the "with" and "without" situations. An estimate of the rate of technical change to be included in the analysis could be obtained from national or area trends etc.
- (c) Input Prices are constantly changing, usually increasing. If the decision maker is to be provided with a realistic appraisal of an investment situation the observed facts of unit price increases or decreases should be included in the evaluation. If output prices are assumed to be constant, and unit input prices are increasing a "cost-price squeeze" is thereby built into the flows in the same way as it might well be expected to operate in reality. Estimates of unit price increases are available for some types of farming.⁴
- (d) Taxation should not be included in studies undertaken from the national viewpoint. Mention should be made however, of the likely effect of taxation on the behaviour of people affected by the scheme. Both "before" and "after" tax figures should be presented for studies undertaken from the individual point of view. From the regional viewpoint taxation represents an important transfer to or from the region.
- (e) Depreciation presents a problem with no unique solution. A recommended treatment, as a simple rule of thumb, of depreciation and replacement costs is as follows - until the project becomes "established" and the new "equilibrium" level of production is obtained, cash flows should include net replacement costs for equipment at the termination of its physical life. After this point the sinking fund formula should be used to calculate an annual equivalent or annuity to represent net replacement costs. This annuity is then accepted as the value of depreciation. If the development period is short, i.e. less than 5 years, the annuity should be calculated for the whole period of analysis.
- (f) Residual Values. The suggested method of accounting for depreciation in the calculation of flows aims at maintaining the investment intact and in an efficient operating condition. Residual values can as a general rule be ignored, especially in longer term studies, and certainly when flows are discounted to infinity.

4. e.g. (1) Meat & Wool Boards' Economic Service Cumulative Cost Index.
 (2) Input Price Index from B.P. Philpott, et al. "Estimates of Farm Income & Productivity in New Zealand 1921-65, A.E.R.U. Publ. No. 30.
 (3) Index of Prices Paid by Dairy Farmers, Farm Economics Section of New Zealand Dairy Board.

6. Period of Analysis

If a project is expected to continue for a certain specified time period, obviously this period will dictate the period of analysis and the consequent calculation of cash flows. Many agricultural projects, e.g. drainage and irrigation channels etc., can have an unlimited life if regularly maintained. Further, it may not be possible to forecast at what date structures become obsolete or redundant. The recommended procedure for permanent structures whose life cannot be estimated with reasonable accuracy is:-

- (a) calculate cash flows for the development period
- (b) capitalise to infinity cash flows which are expected beyond the new equilibrium position.

The termination point of the development period may be difficult to define due to very small changes in the flows, as the new equilibrium position is approached. As a further rule of thumb it will probably be satisfactory to capitalise flows when successive cumulative present values vary by as little as 5.0 - 7.5 per cent.

In long-term projects, there is little difference between the discounted value of cash flows which terminate at infinity and at say 100 years. If, however, comparison is intended with projects of a similar technical nature, which have been evaluated for a given number of years, further results referring to the same time period should be obtained.

7. Discount Rate

Amid all the discussion on discount rate, the ultimate decision is usually which rate to use, as long as it is within about 5% to 7%. If the recipients of benefits are specifically those who incurred the costs, the cost-of-capital technique outlined elsewhere (Paper 4) would provide an appropriate discount rate. In other cases, specifically where studies are undertaken from the national point of view, the recommended discount rate is the next lowest one half of one per cent below the monthly average of Government Security yields on outstanding long-term loans at the end of the previous financial year. These are quoted in the Reserve Bank of New Zealand Bulletin in the table "Share Prices and Interest Rates".

Foreign capital should be discounted at the rate of interest on the most recent World Bank loans. This information is usually available from Reserve Bank publications.

8. Index of Overseas Exchange

This index is meant to represent the degree of over- or under-valuation of the New Zealand currency. This index would vary from time to time as the economic position in New Zealand vis-a-vis the rest of the world varies. No suitable index can be recommended at this stage.

Reference should be made to the Treasury Department or to the Reserve Bank, if an estimate of this index is required.

9. Output Prices

In historic studies the question of output prices has a self-evident solution. Inevitably actual prices are used. Only when special aspects of historical studies are emphasised should actual output (and input) price be deflated.

In forward looking studies there is no unique solution to the dilemma facing those who require estimates of future prices, particularly over several years. Since both the magnitude of the cash flows and their sequence affect the usual criteria, both aspects must be considered. The disturbance due to output price fluctuations which defines the sequence of fluctuations in cash flows is best overcome by the assumption of a constant price level. If available data show some long term trend in output prices and it can reasonably be expected to continue, this may be included. However, with our present state of knowledge any attempt to forecast the fluctuations in various commodity prices would be unwise.

If we can accept the desirability of using a constant price for forward-looking studies, the next question is the level of the constant price. Should the price be based on past, present, optimistic or pessimistic price levels? Probably past prices are one of the most satisfactory indication of future price levels; on this basis the following are suggested:-

- (a) for short-term studies (i.e. less than 20 years), output price levels should be the mean of the previous five years' annual average levels;
- (b) for long term studies, output price levels should be the mean of the previous ten years' annual average levels.

If these are not readily available, the Government Statistician's figures should suffice. If the above is adopted there will be little variation in prices between practitioners and between studies commenced in consecutive years.

If reliable long-range projections of prices are available they should of course be used. If production arising from the project is expected to influence prices significantly, the prices with and without the project could be averaged to obtain the price incorporated in the budgets. Ideally a range of prices should be used - this will be discussed in Section 10.

10. Sensitivity Analysis

If assistance from a computer is available, practitioners should feel obliged to explore thoroughly the behaviour of criteria over a reasonable range of coefficient values. Recommended areas of analysis are:

- (a) The shape of the present value curve (Paper 7), will indicate the sensitivity of present value to the discount rate, and should be explored over a range of discount rates. Does any small change in discount rate materially affect present value? If so, what is the characteristic of the budgeting which is responsible? Should this characteristic be removed or treated in a different manner?

When comparing two or more projects present value curves should be plotted to determine at which interest rate, if any, the present values of the projects are equal. If this occurs, is this discount rate significant for any reason, and what is its relation to the respective internal rates of return?

Simple computer programmes are available or can be written to calculate present values over a range of interest rates. If this range is wide enough the programme will readily show the internal rate of return (or if there are multiple internal rates of return).

- (b) The sensitivity of present value to output price levels should invariably be explored. How does present value change with reasonable changes in price levels? At what price level does present value become zero, and is this a price which can be reasonably expected to occur? How far is this price from prevailing price levels? When complementary products are produced, e.g. wool and lamb, the product prices should be varied simultaneously, and by similar percentages, to avoid unnecessary confusion which often adds nothing to the general results. Prices should be varied at units of one per cent to allow comparison with other studies.
- (c) The sensitivity of present value to doubtful or critical coefficients. If the derivation of any coefficient has been based on unsatisfactory evidence, or if the coefficient is obviously critical to the study, a full exploration of its influence on present value should be undertaken, over all reasonable ranges of its value. What percentage change in present value occurs from a given percentage change in the coefficient? What percentage change is necessary to

force present value to zero? Input prices, rate of investment, and technical coefficients should be considered for sensitivity analysis.

11. Double-counting

Instances of double-counting have occurred in overseas studies where some primary benefits were counted twice, both as primary benefits and as spillovers. This has not, to date, occurred in New Zealand studies. Benefits should be systematically calculated and every care taken to ensure that no item appears in more than one category of benefit. A common point of confusion relates to the inclusion of increases in land values and income increases. It is not valid to impute to a project increases in the capital value of land which are expected to result from increased income which has already been included in the flows. This would, in effect, be double-counting of the effect of increased income, since land values are related to income-earning capacity.

12. Presentation of Results

The format of results and the criteria developed will depend on the original aim of the exercise. Some general suggestions can be made:-

- (a) That the evaluation of a project is best made in terms of present values, as the most meaningful criterion. For reasons outlined earlier in this volume (Paper 7 particularly) the internal rate of return has serious disadvantages compared with the present value criterion. Present value, however reflects the size of the project, and gives an unsatisfactory indication of the efficiency of capital. The V/C ratio should be used in conjunction with present value (V-C) if the efficiency or productivity of capital is required.
- (b) Comparisons between two or more investments are probably best made in terms of present value. Only if the present value curves (i.e. present value plotted against discount rate) of each investment are known not to intersect at discount rates between either internal rate of return and a reasonable upper limit of commonly used discount rates, can the internal rate of return contribute a great deal to interpretation of results.
- (c) Various modifications of the V/C ratio are often useful, when particular aspects of the desirability of the investment require further elaboration. Some of these have been mentioned by Mr Johnson in Paper 9. The V/C ratio refers to the ratio of gross benefits to gross costs, and unless both of these have been calculated

it should be specified that the ratio used is a modification of the usual V/C ratio.

- (d) A statement of opinion on the likely magnitude and effect of intangible benefits or spillover effects should be included.
- (e) That the values of V-C and V/C be specifically stated in terms of the items included in the calculation, e.g.

<u>Primary</u>	V-C and V/C -	including primary benefits only,
<u>Secondary</u>	V-C and V/C -	including secondary benefits when calculated,
<u>Total</u>	V-C and V/C -	including all tangible primary, secondary, spillover and exchange benefits.

- (f) If variations in the scale of the project are possible, results should include conclusions on the 'best' scale for implementation.

13. Expected Values

If estimates of the probability distribution of possible (e.g. price) situations are obtainable, the analysis will benefit from the calculation of an expected value of the present value.

14. Re-appraisal

Reports should be prepared in a manner which facilitates periodic re-appraisal if technical or economic conditions in the years following the original report prove to be significantly different from those assumed in the original study. Rapid changes in markets, or production methods, could make re-appraisal desirable.

15. Investment and Financing

Some practitioners, e.g. catchment board officers, must be concerned both with the economic desirability, and the source of finance, of a project. It is imperative however that these two aspects remain separate in the compilation of a report. Any project should be recommended or rejected largely on its economic desirability, and not whether it will appeal to those who may be required to vote for its approval, or whether or not it will make a significant difference to the current burden of rates.

When both investment and financing aspects of a project have to be considered, each aspect should be the subject of a separate report. The investment report will provide information on the economic desirability of the project per se, and the financing report will give recommendations on the source of finance.

16. Policy Conclusions

No investment study should be considered to be complete unless accompanied by a statement expressing the author's views on the appropriate action which the decision maker should take. Irrespective of whether the study has been commissioned by a government body or a local organisation, it is the duty of the practitioner to weigh all the tangible evidence, advise on this basis, and indicate the weight of intangibles associated with a project. He will be ideally and prominently placed in relation to the project he has evaluated and should advise the decision maker on the alternatives available and the steps he considers appropriate.