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COST-BENEFIT ANALYSIS  
AND ITS APPLICATION TO A PROPOSED FREEZING  
WORKS IN HAWKE'S BAY

A Thesis  
Submitted in Partial Fulfilment  
of the Requirements for the Degree  
of  
Master of Philosophy in Economics  
at the  
University of Waikato  
by  
Kuldeep Kaur Gill

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University of Waikato  
1979

"COST-BENEFIT ANALYSIS AND ITS APPLICATION  
TO A PROPOSED FREEZING WORKS IN HAWKE'S BAY"

ADDENDUM

Because of restraints of time and data this study was largely restricted to analysing direct costs and benefits which would arise from establishing a new freezing works at a specific site. In particular, it sought to go beyond the original feasibility study upon which it is based, to assess the benefit to farmers of having stock killed with less delay. A more thorough review of the costs of holding stock would require the application of queueing theory to analyse the timing of stock throughput.

The indirect effects that the establishment of a new works would have upon other works in the country has not been assessed as suitable data was not available. It seems probable that if both these limitations could have been overcome, the benefits resulting from the establishment of the new works might have been less than is shown in the study.

The study did not attempt to assess the effects of siting a new works in the Hawke's Bay upon overall transport costs in the industry. This would require an additional study using operations research techniques, which it was felt would have extended the study beyond reasonable bounds, given the time restraint.

Any reference to this study should take into account the assumptions upon which it was based, the limitations of data and the necessary restrictions of scope.

ABSTRACT

The meat freezing industry in New Zealand is a licensed industry. Under the Meat Amendment Act 1976, anybody proposing the erection of new killing facilities is required to prove its viability from the nation's view point. The main object of this thesis is to suggest an approach (cost-benefit analysis) by which such a national evaluation can be achieved in a convenient and comprehensive fashion. This study of the application of cost-benefit analysis to the meat freezing works is a first attempt of its kind and shows how the technique can assist decision makers in this field.

The study consists of thirteen chapters and is divided into two parts. In Part One, which comprises six chapters, the general principles of cost-benefit analysis are discussed and the basic steps involved in evaluating projects with this technique are reviewed as: enumeration and valuation of costs and benefits, selection of the investment criterion and social rate of discount, problems of risk and uncertainty, and finally the question of equity. It is concluded that the technique is a useful instrument in the hands of a decision maker inspite of its numerous limitations.

Part Two is concerned with a case study of a proposed freezing works in Hawkes Bay. In the first two chapters, the background information and a summary of the commercial feasibility study of the project are given. In Chapter 9 national objectives are reviewed and in the light of this the different sectors of the economy affected by the proposal are identified. An assessment of the kill available to the new works is made in Chapter 10, where data limitations were experienced and a lot of informed judgement has been used.

In Chapter 11 costs and benefits are quantified and they also presented many difficulties, particularly those relating to the farm sector and the transport industry. Finally the project is evaluated at market prices as well as at shadow prices (Chapter 12), and a brief sensitivity analysis is carried out. The results of the analysis suggest that the project is highly beneficial to the nation and its social net returns are considerably higher than that of private net returns.

The study however does not pretend to offer an unequivocal solution. The analysis is open to criticism and it is hoped that its limitations will stimulate others to take up research where this study leaves off.

ACKNOWLEDGEMENTS

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All views expressed and all shortcomings are, of course, my own.

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PART ONE

COST-BENEFIT ANALYSIS:

REVIEW OF LITERATURE

CHAPTER 1INTRODUCTION

Cost-benefit analysis is a practical way of assessing the desirability of projects by taking into account all the relevant costs and benefits. It is not merely a financial feasibility analysis but goes beyond that by embracing the social impacts of projects. The distinguishing feature of the technique is that costs and benefits are viewed and valued from society's point of view, specifically taking externalities (i.e., both tangible and intangible) into account. By doing so, it encompasses not only a wider view but also a longer view than the traditional limited methods of investment analysis. Its aim is to aid society to channel resources into projects which will yield the greatest net benefits to that society. The technique may be used to evaluate whether or not a particular project is worthwhile, which is the best of several alternative projects, or when to undertake a particular project.

The concept of cost-benefit analysis as an aid to government decision making is not new in the literature. Although the subject came into prominence only in the nineteen sixties, its fundamentals were laid down by a French engineer, Dupuit, whose classic papers on the utility of public works appeared as long ago as 1844 [Dupuit, 1844]. However, cost-benefit analysis was developed on an ad hoc basis as Hammond [1958, p. 3] points out that the technique is, "in origin an administrative device owing nothing to economic theory and adapted to a strictly limited type of Federal activity - the improvement of navigation". The first systematic attempt to apply the technique was made in the United States for evaluating water resource projects

during the 1930's. Meanwhile academic interest in appraisal techniques had also grown and the real break-through came in 1958 with the simultaneous publication of Eckstein's "Water Resource Development" [1958], McKean's "Efficiency in Government through System Analysis" [1958] and Krutilla & Eckstein's "Multiple Purpose River Development" [1958]. Recently its use has become so popular that it has been employed in many areas of the economic activity including the private sector<sup>1</sup> as well as the public sector. As Irvin [1978, p. 79] states "cost-benefit analysis has gradually evolved away from a narrow concern for special types of non-commercial undertakings towards a more fully articulated set of concepts and tools applicable in principle to all investment decisions". This is for several reasons. Firstly society has become more aware of the misuse of resources. Secondly there has been the growth of the public sector with many large investment projects. Coupled with it is the role of the aid agencies (e.g. World Bank etc) which have tightened the standards of project evaluation. Yet another reason, as explained by McKean [1958, pp. 5-8] long ago, is the rapid development of appraisal techniques such as operations research, system analysis etc., both in the public and private sectors of the economy.

Cost-benefit analysis has many facets and many applications. Its use has spread in areas ranging from water resource development [Krutilla & Eckstein 1958; Maass *et al* 1962], transportation [Reynolds 1956; Foster & Beesley 1963], urban development [Lichfield 1962; Rottenberg 1965], and industrial project evaluation [Little &

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<sup>1</sup>For projects which require some kind of government approval or assistance.

Mirrlees 1968; UNIDO 1972] to social services such as health [Mushkin 1962; Klarman 1965] and education [Weisbrod 1962; Hansen 1963]. Although its application in advanced capitalist economies continues to be more widely used in cases of non-commercial undertakings, it has become relatively more important in the context of planning in the developing countries in the 1970's. The genesis of Little & Mirrlees [1968] and UNIDO [1972] publications lies more in the areas of development economics than in traditional cost-benefit analysis literature. However, even in the 1970's, some authors such as Dasgupta & Pearce [1972], and Mishan [1975] have virtually omitted any mention of development issues. Inevitably the details of cost-benefit analysis differ from project to project and from country to country depending upon the nature of the project and the economic environment respectively. In this Part One, therefore, I intend to review only the general principles of cost-benefit analysis and its limitations.

The basic formulation which covers most cost-benefit analysis is: one identifies costs and benefits and then assigns numerical values to them and arrives at decisions by adding them up and accepting those projects whose benefits exceed costs. The broad principles of cost-benefit analysis can be discussed under the following headings:

- (1) Enumeration and valuation of costs and benefits.
- (2) Decision rules i.e. investment criteria and the social rate of discount.
- (3) Risk and uncertainty.
- (4) Welfare criteria and income distribution.

No doubt the above classification is somewhat arbitrary, but it will help in making the exposition simple and clear.

CHAPTER 2ENUMERATION AND VALUATION OF COSTS AND BENEFITSA. ENUMERATION OF COSTS AND BENEFITS

The first question arises as to what costs and benefits are to be included in the project evaluation? Since a cost-benefit analysis is done from society's point of view, it takes into account not only the costs and benefits which can be measured in monetary terms but also encompasses relevant nonquantifiable and noncommensurable costs and benefits as well. In other words, the analysis is concerned with *all* costs and *all* benefits accruing from projects, whatever their form and to whom so ever they accrue. However in practice it is exceedingly difficult to trace the total impact of a project on the economy, either because this cannot be readily identified or because identification itself imposes a very high cost. It is useful to classify the costs and benefits as primary (direct) and secondary (indirect).

Primary or direct costs and benefits refer to those losses and gains that accrue directly to the organisation sponsoring the project. In this sense, primary costs include the value of goods and services that are used in order to construct and operate a project. They also include interest during construction and all other identifiable expenses and losses. In short direct costs consist of installation costs and operation, maintenance, and replacement costs. Primary benefits refer to those goods and services which the project is designed to provide. These goods and services may be valued at market prices or may be measured by the maximum amount of money which the consumers are willing to pay.<sup>1</sup>

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<sup>1</sup>In case of collective goods

Secondary or indirect costs and benefits refer to those indirect effects which are induced by the project but are not taken into account in the quantities or prices of inputs or outputs of the project itself. These are known as "externalities" or "spillovers". McKean [1958, pp. 134-50] distinguishes between technological and pecuniary spillovers. Technological spillovers are those effects which alter either the technical efficiency of other producers or the satisfaction that consumers derive from their resources. For example, the water pumped from one mine affects other nearby mines. The pecuniary spillovers are the income redistributive effects of a project occasioned by shifts in prices of products or factors. For example, the improvement of a road may lead to greater profitability or more employment for businesses along that road.

Pecuniary spillovers are usually not included in the analysis since the gains to some firms would be offset by losses to other firms. They constitute purely transfer payments. Unless the objective function is other than the efficiency one, such effects should be ignored. However technological spillovers should be taken into account as they represent a genuine cost to society.

In addition to the above, externalities may also include "linkage effects" and "multiplier effects" [ODA, 1972, pp. 13-15]. Linkage effects are the income generated in industries which supply inputs or process outputs of the project under consideration. "Forward" linkage effects are the repercussions on those industries which process or use the outputs produced by the project; whereas "backward" linkage effects occur in those industries which supply materials used by the project. Harberger [1972, pp. 47-48] is of the opinion that such linkage effects should be taken into account only if as a consequence of the project, changes do occur in the output of an

industry for which marginal social benefit is not equal to marginal social cost. If social benefits equal social costs at the margin no adjustment is needed.

Multiplier effects result from the additional rounds of expenditure of the incomes generated by the project. It may be argued that such effects should logically be included in the analysis if some unemployed or underemployed factors of production exist in the economy. However in case of difficulties of estimating them in quantitative terms, a qualitative description will suffice.

Many economists are sceptical about the extent to which these indirect effects can be measured. According to Hammond [1966, p. 212] "there is nothing inherently difficult about the *idea* of secondary benefits; it is their vagueness, limitlessness, and insusceptibility to plausible estimation that makes them objectionable". Even Foster [1963, pp 62-65] considers full "social appraisals" in which all costs and all benefits to whom so ever they may accrue are to be estimated as a "piece of utopianism". However it may be suggested that where significant external effects exist, an attempt should be made to achieve plausible quantification as far as possible. In cases where it is impossible to do so, a qualitative or literary statement should be made and the significance of such effects should be left to "informed judgement". Sometimes such effects prove decisive.

#### B. VALUATION OF COSTS AND BENEFITS

Having enumerated the costs and benefits, direct or indirect, that are to be included in the analysis, it is then necessary to put a monetary value on them. In a perfectly competitive economy with no externalities, allocation of resources on the basis of market prices of goods and factors would result in Pareto optimality for a given income distribution. Market prices of goods and factors would equate the

marginal social cost (MSC) of producing and the marginal social value (MSV) of using the relevant goods and factors. In the real world however, prices are not likely to reflect these marginal social costs and benefits (values), owing to the existence of imperfectly competitive markets and external effects. Therefore, some costs and benefits may be correctly registered in markets by prices, some may not be correctly registered by market prices, while others may not be registered in any market at all. Under these circumstances, evaluation based on market prices would result in a misallocation of resources as there would be a heavy strain on the resources that are under-priced or not-priced at all, while part of the resources that are over-priced would be left idle. It is thus necessary to introduce into the evaluation procedure a device intended to reflect as accurately as possible the intrinsic values of the goods and factors involved, and the art of cost-benefit analysis lies in assigning prices to goods and factors which do reflect their real costs and benefits to society. The name given to these assigned prices is "shadow prices" [McKean, 1968, p. 33; Marglin, 1962, p. 50] , or "accounting prices" [Little & Mirrlees, 1968, p. 37] . It must be admitted at the outset that it is no easy job to obtain adequate estimates of the appropriate accounting prices to use for project evaluation. The problems that arise in estimating such prices can be discussed under two headings:

- (1) Market items - market prices may be either distorted (e.g. by monopoly, taxes, subsidies, or controls) or reflect market disequilibrium (e.g. unemployment or balance of payments problems).

- (2) Non-market items including public goods and the external effects of market items - methods of evaluation must be devised for items such as time, pollution, and other environmental risks, human life, etc.

### Market Items

In all economies, the price structure is so distorted that correcting prices in the public sector involves the problem of "second best" [Lipsey and Lancaster, 1956-57]. Cost-benefit analysts have been notable for their refusal to acknowledge this problem. As Margolis has remarked, "these arguments are deferred to in footnotes and then ignored"<sup>2</sup>. A large number, if not all, of the assigned prices which will be considered are of this "second best" kind. Let us examine some of the various methods suggested to correct market prices.

(i) Market imperfections: Departures from Pareto optimal situations arise when monopolistic elements or other market imperfections are such as to deviate market prices away from those which would otherwise prevail under perfectly competitive conditions. Suppose a project uses steel produced by a monopolist and sold above its marginal cost. The question now arises of using the appropriate price - should we use its market price or its marginal production cost? Following the well established convention of cost-benefit analysis, the answer depends on how the rest of the economy adjusts when the project is undertaken i.e. on the opportunity cost of steel. If the production of steel is expected to increase by the full amount used by the project, obviously it should be charged at its

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<sup>2</sup>In a comment to McKean's paper [1968, p. 72].

marginal cost - the true economic cost of producing each added unit. If no extra steel will be produced, but the supply to the project will be diverted from other uses, then the use of steel by the project should be valued at the market price which represents its alternative use value [McKean, 1968, pp. 38-39]. However if a mixture of the two responses is expected, a weighted average of market price and marginal cost should be used.

Harberger prefers to use market prices for material inputs - steel in our example. The marginal cost principle should be used *only* if in addition to the increase in output of a material as a consequence of the project, that material does not have an alternative use in which its value lies above the cost of producing the material [Harberger, 1972, p. 55].

(ii) Taxes and Subsidies: Market malfunctions may arise due to the existence of indirect taxes and subsidies. In a situation where an *input* is subject to a tax, Harberger suggests that the producer's supply price should be used if production is expected to increase by the full amount of the project's demand, and the demand price if no growth in output is expected. Suppose  $S(P)$  is the total supply of the input in question and  $D[P(1 + t)]$  is the total private demand where  $P$  is the price, net of tax, and  $t$  is the rate at which input is taxed. Then the cost to the project of an additional unit of input will be a weighted average of  $P$  and  $P(1 + t)$ . The weights can be derived from the identity

$$G \equiv S(P) - D [P(1 + t)]$$

by differentiating with respect to  $G$ , which refers to the project

demand [Harberger, pp. 303-04]<sup>3</sup>. The same view is also expressed by Hansen in UNIDO [1978a, p. 27].

In the case of a tax upon the *output* of a project, benefits should be measured by market price gross of tax, as the value to buyers is the price that they pay for the product which includes the tax. Note here, it is assumed that there is no economic rationale for the indirect tax except the need to raise revenue. On the other hand, if there is a rationale, such as the correction of external diseconomies, benefits should be measured by market price net of tax [Harberger, 1972, pp. 57-58].

Most economists, however, prefer to value inputs (outputs) net of indirect taxes and subsidies, i.e., at factor cost. The ECLA Manual [1958, p. 203] recommends this procedure on the grounds that "greater or lesser customs duties or sales taxes cause variations in the selling prices, unrelated to the effort involved-----". Similar observations can be made for subsidies, inasmuch as they are 'negative taxes'".

As far as direct taxes are concerned, private profit making decisions do take into account income and profit tax payments but for public investment it is irrelevant. Here society is concerned with the use of real resources and should therefore exclude all transfer payments [Prest & Turvey, 1965, p. 693].

(iii) Labour: Observed wage rates are often misleading, when at the going rate, part of the labour is involuntarily unemployed.

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<sup>3</sup>Harberger, A.C., "The Opportunity Costs of Public Investment Financed by Borrowing", in R. Layard (ed.), *Cost Benefit Analysis*, Penguin, 1972, pp. 303-10. The above is an excerpt from Harberger [1969].

To determine the shadow wage rate of labour, classified by different skills, types, and regions is an extremely complex procedure. Almost all economists agree that labour should be valued at its opportunity cost, although different costing procedures are needed relevant to the particular circumstances. If a project employs labour which would otherwise be unemployed, the true cost to society appears virtually zero since the person's alternative is to do nothing, to produce nothing. Allowance should be made for the value of the forgone idleness (i.e. lost leisure). According to McKean [1968, p. 43], 'idle' people are often seeking information that has value, both to them and to society. This allowance should be less than the wage if the labour was involuntarily unemployed. Moreover unemployment today does not necessarily imply unemployment several years hence. In the last quarter of the twentieth century it seems unreasonable to assume that mass unemployment will persist year after year. Cost-benefit analysis should take this fact into account while projecting costs and benefits year-by-year.

The ECLA Manual [1958, p. 205] suggests that agricultural wage should be considered as the opportunity cost or shadow wage of labour diverted to urban employment. It seems inadequate as something more is required to attract labour from rural to urban areas. In fact, in order to calculate the opportunity cost of labour brought into a new project, we should add to the marginal value of labour in its current use, the sum that would exactly compensate the worker for all costs, subjective and objective, associated with moving into employment in the new project [Mishan, 1975, p. 67].

In countries where the level of investment is sub-optimal, the effects on consumption of employing more people must also be taken into account [Sen, 1972, pp. 493-94]. The same point is elaborated by Little & Mirrlees [1968, pp. 157-77] as well by using numeraire savings rather than consumption. They state that the shadow wage

should be between the consumption of labour and its marginal product because in most of the developing countries, the consumption of labour is significantly greater than its marginal contribution to production. The exact value between these two extremes depends upon the "consumption rate of interest"<sup>4</sup> and the amount of extra savings generated by new investment.

If government has already decided on a national unemployment policy, then employing labour on the project may mean reducing employment and output elsewhere in the economy. The cost of labour is then assumed by his present wage. However Prest & Turvey [1965, p. 695] suggest that while correcting market prices for labour, the analyst should limit himself to the local conditions of labour only and should not be concerned with national unemployment.

(iv) Foreign exchange: Another problem arises over the foreign exchange component of costs and benefits associated with the project. The existence of tariffs, quotas, and other foreign exchange controls in many countries indicate that there is a particular scarcity of foreign exchange and the domestic currency is, therefore, overvalued at the official exchange rate. The crucial point is that in such a situation the social value of a unit of foreign exchange, measured in terms of domestic resources, is greater than the official price. Now the problem arises how should imports and exports be valued? One approach as suggested by ECLA Manual [1958, p. 204] is to use the shadow price of foreign exchange on the basis of purchasing power parity formula. This has been severely criticised by Harberger [1972, p. 54] as he states, "Rather than looking backward to a base year and

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<sup>4</sup> For detailed discussion, see Little & Mirrlees [1968, pp. 39-42].

being concerned with monetary changes having taken place in the past, cost-benefit analysis looks at the present and future, and attempts to evaluate alternative projects in 'real' terms".

The UNIDO Guidelines [1972, pp. 215-17] favour the use of shadow price of foreign exchange as reflected by the demand price in the domestic economy. It can be obtained by the weighted average of the ratios of domestic market-clearing prices to official c.i.f. prices, the weights being the marginal changes in imports and exports induced by the project. The foreign currency prices of both importables and exportables are then multiplied by this shadow price to get the correct social investment decisions. Note here, this method is based on the assumption that the existing protection structure will remain unchanged. The above approach is also advocated by Harberger [1972, pp. 52-53].

Recently a new approach to the shadow price of foreign exchange has been recommended by Bacha & Taylor [1971, pp. 222-24]. They suggest that shadow exchange rate should correspond to the equilibrium price (determined in a floating foreign exchange market) rather than the official price. In effect, this shadow price is used to convert the foreign currency prices of tradables (imports and exports) into domestic prices to correct for the overvalued domestic currency. The above procedure assumes that trade-liberation will take place with exchange rate flexibility.

Little & Mirrlees [1968, pp. 90-93, 105-12, 143-56], come down in favour of using foreign prices - not domestic market prices. They prefer to measure imports and exports (in fact all goods which in optimal conditions would be traded internationally) at their world prices at border i.e. at their c.i.f. price and f.o.b. price respectively, and to deflate (usually) the prices of nontradable goods to their estimated free trade levels. In economist's

terminology, imports are to be valued at their marginal import cost and exports at their marginal export revenue. They justify this approach on the grounds that there are more traded goods than non-traded goods, which is probably true in case of industrial projects. Moreover, they point out that, "world prices are used ----- simply because they represent the actual terms on which the country can trade" [p. 92]. Perhaps it was their intention to show to governments the cost of distorted trading policies followed by them.

Stewart & Streeten [1972, pp. 76-84] criticize the Little-Mirrlees proposals as being a piecemeal approach to development which ignores the necessary linkage in the economy. Moreover, free trade policy may not be optimal under certain conditions. Though more in favour of the open-economy approach to development, Sen [1972, p. 499] points out that the Little-Mirrlees method requires a rather extraordinary assumption about the project evaluator's areas of control<sup>5</sup>. According to Mishan [1971], the Little-Mirrlees approach is a departure from the Pareto principle [p. 98] and he strongly recommends that the value of imports and exports should be 'calculated by reference respectively to the subtraction from, and addition to, the country's domestic value; and not by reference to world prices of traded goods' [p. 94]. However, Deepak Lal [1974] and Stern [1972] consider the latter as being a more practical approach.

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<sup>5</sup>For a reply to these criticisms, see Little & Mirrlees [1972].

(v) Non-marginal changes: Difficulties also arise in using the prevailing market prices, when the scale of the project is so large as to have marked effects on these prices. This is the problem of "indivisibility". Now the question is - in the analysis of benefits, should the additional output be multiplied by the preproject or postproject prices? In case of a linear demand curve, Lerner [1944, p. 197] suggests that an unweighted average of before and after project prices should be used. A diagram will make this clear.

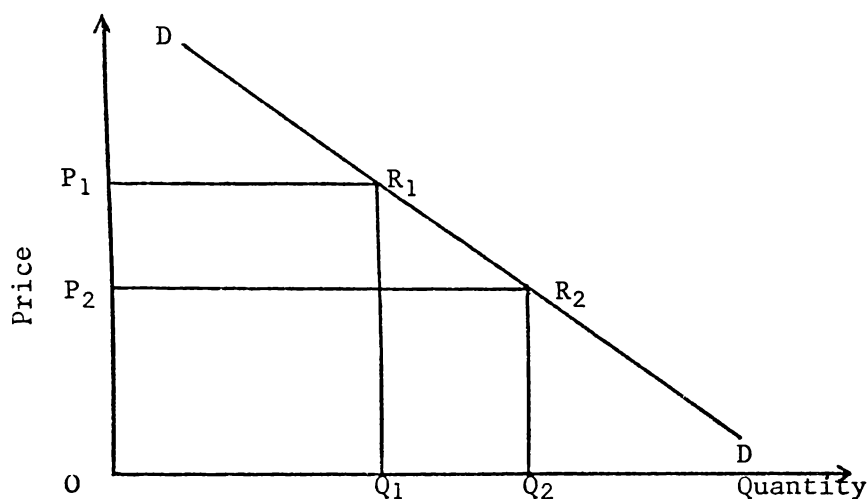


Figure 1. Non-marginal changes in prices

In Figure 1 the demand curve DD shows the marginal valuation of the various units of output that might be placed on the market. Suppose the project increases output flow  $OQ_1$  to  $OQ_2$ . In order to have correct value of the project's output, we should add the marginal valuations over this increase in output, which is equivalent to the area  $R_1 Q_1 Q_2 R_2$ . Note here, this area ( $R_1 Q_1 Q_2 R_2$ ) can be approximated by the expression

$$\frac{1}{2}(P_1 + P_2) (Q_2 - Q_1)$$

i.e., the project's output is reckoned at the average of the pre and post project prices.

On the cost side, the indivisibility<sup>6</sup> will raise the prices of the inputs utilized to build the chunk of equipment. These inputs, analogous to the demand side, should be valued at a price half-way between the original and ultimate level. In short, in appraising projects which cause prices to change, the benefits and costs should be measured at the average of the price levels that would prevail before and after the project.

#### Non-Market Items

The evaluation of non-market items presents the most serious problem in cost-benefit analysis and perhaps the most controversial as well. There are certain goods or services or effects, for which markets in the usual sense do not exist. There are several reasons for this. The government may have a distinct policy of not charging due to equity considerations. Sometimes it may be impracticable to charge for the benefits on account of prohibitive administrative costs. Frequently there is no market simply because property rights do not exist under the prevailing legal conventions or it is too expensive to create the property rights. Whatever the reason for non-existence of markets is, the cost-benefit analyst must come to terms with such items as they play a crucial role in the ultimate decision making. The problem is discussed under two headings:

(i) Intangibles: Intangibles are those factors which cannot be directly quantified or monetised. Only an indirect quantitative measure is possible. Recently, many methods have been evolved for handling intangibles. First, prices can be assigned by finding out what

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<sup>6</sup>The detailed treatment of indivisibility is given in Lerner [1944, pp. 174-99].

the consumer would be willing to pay if there were a market for this intangible item, or what they would require to put up with this intangible if, say, it is a nuisance. The Commission<sup>7</sup> on the Third London Airport Study [1970 & 1971] made use of this approach. However, the questionnaire approach has similar problems to that of conducting any other survey and as is well known it could be unreliable.

Another way to assess the value of such items is to observe the behaviour of economic agents. For example, if a person chooses the faster, more expensive mode of travel, it could be argued that he implicitly values the savings in time at more than the difference in cost of the two modes. Harrison & Quarmby [1969] have tried to measure the value of savings in time resulting from a transport investment by making use of this approach. Mansfield [1971] also attempted to infer valuation from people's behaviour in order to assess the value to the community of a recreational facility such as a National Park. However economic decisions which involve human behaviour are difficult to quantify and the analyst should be very cautious while doing this. Lu [1969, p. 136] gives an example of the famous Hawthorne (Illinois) experience. The Western Electric Company (U.S.A.) conducted experiments during 1927-32 to find out the effect of lighting and other working conditions on production. Each improvement as expected, brought increased production from the employees. However when the improvements were reversed step by step to the original conditions, the production still kept on rising. This apparent paradox shows the difficulties of deriving valuation from human reactions.

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This is sometimes known as The Roskill Commission.

If all these fail, the attempt to measure intangibles in monetary terms may have to be abandoned. However in this case, non-monetary costs and benefits may be listed in the final analysis as "contingencies". For example, benefits of a project may exceed costs by \$15 million, but at the same time, there may be probable loss of 200 lives due to the project. Now the decision maker, at least, can consider whether those 200 lives are worth the \$15 million benefits. However the attraction of this "contingency" approach lessens once two or more intangibles exist as it becomes difficult for the decision maker to find the appropriate trade-off.

(ii) Public goods: There remains the problem of valuation of public goods - the goods which are in joint supply<sup>8</sup> and where the principle of exclusion does not apply<sup>9</sup>. In other words, public goods are not only available to more than one person, but their consumption by one person does not reduce their availability to others. The difference between private goods and such public goods can be illustrated diagrammatically as shown in Figure 2(a) and Figure 2(b). The aggregate demand curve of a private good is obtained by horizontal summation because each person derives gains only from the water he consumes, whereas in case of public goods, the vertical summation is appropriate since both persons consume flood protection simultaneously.

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<sup>8</sup>The term "joint supply" is used by Head [1962, p. 201]. Some writers such as Musgrave [1969a, p. 126] have used the term "non-rivalness" in place of "joint supply".

<sup>9</sup>However, according to George & Shorey [1978, pp. 223-24], the principle of exclusion may or may not apply to public goods. For example, it is possible to exclude people from the use of an uncongested road bridge, but not in the use of national defence. In effect, excludability is a matter of degree only.

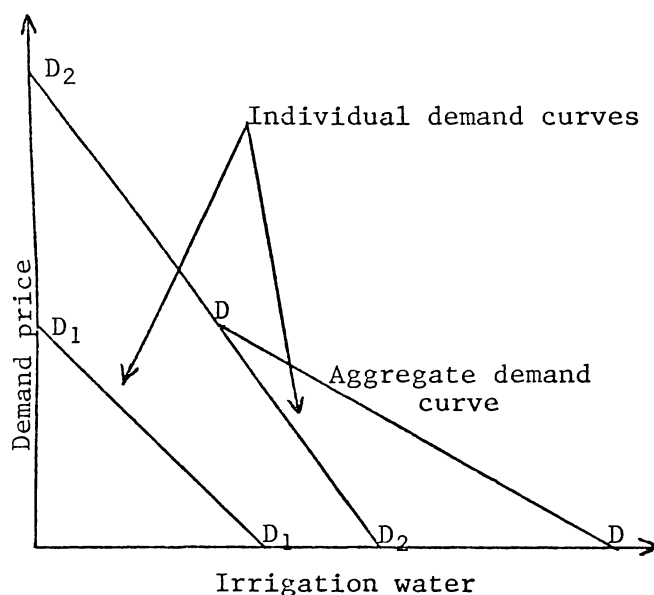


Figure 2(a). Private goods

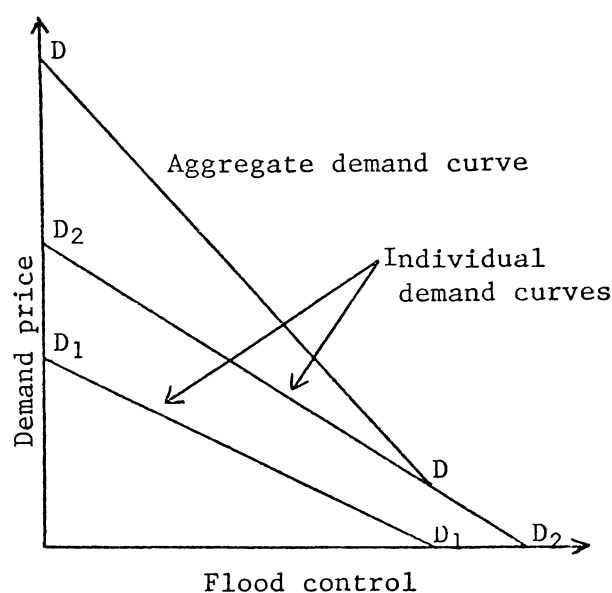


Figure 2(b). Public goods

Source: A. Maass *et al* [1962, pp. 45-46].

There is no way of getting people to reveal these preferences for public goods because they will have an incentive to understate their true demand owing to the "free rider" problem inherent in such goods. Some have suggested making use of market prices for similar items operated commercially or market prices for the same items in other countries. However, the chances of producing misleading evaluations by using such prices are great [McKean, 1968, p. 50]. Obviously, no set of true prices exists by which the cost-benefit analyst can compute benefits. Whenever cost-benefit analysis becomes difficult on account of such factors, it is still useful to compare the costs of providing the same benefit in different ways. This is called cost-effectiveness.

### Price Changes Over Time

In quantifying costs and benefits, it is important to make allowances for anticipated future changes in prices. Changes in the general level of prices (i.e. inflation or deflation) have no effect on the economic analysis of a project, as a parallel movement of all prices would not alter the real cost-benefit relationship. However changes in relative prices can have a determining influence on the worth of a project and all such changes must be explicitly taken into account. Here the problem is to identify situations in which a particular price is expected to rise or fall relative to the general level of prices. According to Turvey [1971, p. 8] the most important relative price change to be expected is probably a rise in the real wage rate because of the continued economic growth. Although such changes cannot be reflected with great precision, a calculated attempt is better than ignoring such adjustments. "Sensitivity analysis" can be employed to determine the importance of such price changes to the project evaluation.

CHAPTER 3

DECISION RULES

A INVESTMENT CRITERIA

Suppose the costs and benefits of project(s) are computed with certainty. Now the question arises how should a government choose between alternative projects and indeed should it undertake any of them? Many rules have been suggested but I shall discuss only three among the most important investment criteria<sup>1</sup> available in the literature.

Costs and benefits need to be estimated over the complete economic life of the project. If the costs and benefits per year were constant over the lifetime, it would be sufficient to compare the annual benefits with the annual costs in order to determine the worth of a project as shown in Figure 3.

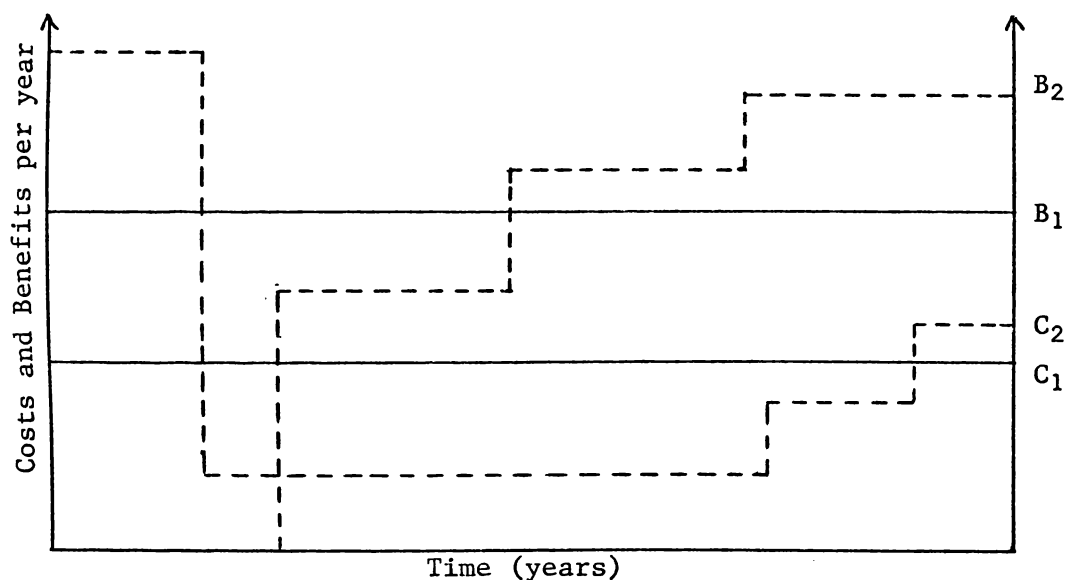


Figure 3. Project's cost and benefit streams over time

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<sup>3</sup>Sometimes they are called decision algorithms.

$C_1$  and  $B_1$  are the cost and benefit lines respectively. However costs and benefits are usually unevenly distributed over time. Most projects need heavy investment during an initial construction period with subsequent lower operating costs and then followed by some years of increasing maintenance costs. Whereas, benefits commence some time after the initial investment and may be uniform from the beginning or built up to some maximum capacity over time. Such cost and benefit streams are shown in Figure 3 by  $C_2$  and  $B_2$ .

Now the problem is how to compare the anticipated future cost and benefit streams? It is well established that present costs and benefits have greater significance than future costs and benefits because money has time value. In order to have a common measure, the frequently recommended technique is to employ discounted cash flow analysis to bring future values to present values. The two most commonly used criteria based on discounting methods are now discussed.

#### Net Present Value (NPV)

The net present value of a project is defined as the value obtained by discounting, separately for each year, the difference of all benefits and costs accruing throughout the life of a project at a fixed, pre-determined rate of discount. The value is discounted to the point at which the project is expected to start. Symbolically

$$NPV = \sum_{t=0}^{t=n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+r)^t}$$

where B refers to the benefits and C refers to the costs and r is the social rate of discount<sup>2</sup> (yet to be discussed). It should be noted that a variation in the discount rate will change the present value of net benefits, and the higher the discount rate is the lower the present value will be.

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<sup>2</sup>The use of a single discount rate, r, assumes that the time value of net benefits falls at a constant rate.

The investment decision rule can be stated as: a project is worthwhile if  $NPV > 0$ , however where projects are mutually exclusive, the project with the highest value of NPV should be selected. The latter needs some refinement. It has to be decided whether to rank the projects by excess of benefits over costs,  $B - C$ <sup>3</sup>; by the ratio of benefits to costs,  $B/C$ ; or by the ratio of excess of benefits (net benefits) to costs,  $B-C/C$ . The last two methods give the same ranking and in subsequent discussion the  $B/C$  ratio has been ignored. It is suggested by Mishan [1975, pp. 193-95] and George & Shorey [1978, pp. 235-36] that if alternative projects are of exactly the size given, the  $B - C$  criterion should be used; however, in case alternatives can be changed in any proportion,  $B-C/C$  is the correct criterion. Lorie & Savage [1955, p. 231] are also of the opinion that for single-period financial constraints, projects should be ranked by their net benefit - cost ratios, i.e., by the ratio  $NPV/C_i$  where  $C_i$  is the constrained expenditure in the relevant period. Where multi-period rationing of funds involve, no simple rule will suffice<sup>4</sup>. According to some [e.g. Howe, 1971, p. 93], if funds are limited so that all projects with  $NPV > 0$  cannot be undertaken, the simple procedure is to raise the discount rate until the set of projects left with positive NPV just fits within the budget.

#### Internal Rate of Return (IRR)

An alternative criterion which has often been advocated and perhaps even more often used in the private sector is the IRR. This is defined as that rate of discount which makes the NPV exactly equal

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<sup>3</sup>B is the present value of the benefits; C is the present value of the costs.

<sup>4</sup>For complex and exhaustive treatment of this problem, refer to Weingartner [1963].

to zero. It is obtained by solving the following equation for P,

$$\sum_{t=0}^{t=n} \frac{B_t}{(1+p)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+p)^t} = 0$$

where P is the internal rate of return.

According to this criterion, a project is recommended if P exceeds the pre-determined social rate of discount. As with the NPV criterion, it remains essential to choose some acceptable discount rate to reach a decision [Bierman & Smidt, 1966, p. 40]. Some writers [e.g. Barish, 1962, p. 171; Harberger, 1972, pp. 27-28] claim that the internal rate of return has an advantage in the fact that it does not require prior specifications of a discount rate and can be calculated on the basis of project data alone. However the calculation of IRR is very difficult and often involves a trial and error process.

#### Choice between NPV and IRR

The question now arises as to which investment criterion should be used to make decisions. In many cases these two criteria give the same answer. There are numerous arguments against using the IRR for specific decisions. One problem arises when comparing mutually exclusive projects because the best project is not necessarily the one with the highest IRR. Feldstein & Flemming [1964, p. 80] point out that the problem can be overcome by calculating the IRR on the difference between each project being considered and each of its alternatives. Thus the mutually exclusive context requires a two part rule to the effect that a project Y be accepted only if

$$P_y > r$$

$$P(y - x) > r$$

where P is the IRR and r is the discount rate [Dasgupta & Pearce, 1972, p. 164].

The IRR is also sensitive to the length of a project's economic life, discriminating against projects with long gestation periods.<sup>5</sup> In addition, the IRR calculations may not give a unique answer as there is the possibility of more than one solution rate. This problem has been discussed by many writers such as Bierman & Smidt [1966, pp. 44-47], Dasgupta & Pearce [1972, pp. 165-67], Harberger [1972, pp. 28-29], and Mishan [1975, pp. 191-93]. According to UNIDO [1978b, p. 179], where major negative net cash flows occur repeatedly during the later life of the project, it is equally possible that the NPV may go positive and negative more than once when applying different discount rates. It is also argued that the NPV criterion allows for the possibility of using different discount rates over the life of the project, whereas this is not feasible under IRR criterion<sup>6</sup>.

The IRR criterion perhaps has an intrinsic appeal because it is expressed as a percentage rather than an absolute magnitude. However the balance still lies in favour of NPV criterion both in theory as well as in practice<sup>7</sup>.

#### Normalisation Procedure

So far methods based on discounting cash flow techniques have been examined. Sometimes it is more useful to consider the terminal value of costs and benefits, i.e., instead of discounting costs and benefits

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<sup>5</sup>These arguments are given in many text books, although the same reasoning can also be applied to the NPV criterion.

<sup>6</sup>Recently a few attempts have been made to use dual rates in IRR criterion.

<sup>7</sup>A comparative discussion of the two criteria is given in Turvey [1963, pp. 93-98], Feldstein & Flemming [1964, pp. 79-85], Bierman & Smidt [1966, pp. 39-47], and many others.

to the present, they are compounded forward to a terminal period - usually the end of the project's economic life. For example,

$$TV(B_t) = B_t (1 + r)^{n-t}$$

where  $TV(B_t)$  is the terminal value of a benefit in period  $t$ ,  $r$  is the rate of compound, and  $(n-t)$  is the number of years between period  $t$  and the terminal date  $n$ . Mishan [1967] supports this procedure on the ground that it is more natural to move forward in time rather than backward.

Mishan [1967, pp. 778 - 84], based on this compounding technique, has suggested an interesting "normalisation" procedure to ensure identical project rankings for all investment criteria. Three rules are to be followed for this normalisation procedure: in ranking a set of projects, each project must have a common outlay and a common investment period. In addition, reinvestment opportunities open to each of the benefits must be fully utilized<sup>8</sup>. Now ranking projects in terms of their "normalised" terminal value will have identical result if ranking is done in terms of "normalised" present value or "normalised" internal rate of return<sup>9</sup>. The procedure appears to be better than the conventional rules as it brings consistency to the various investment criteria.

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<sup>8</sup>The consumption benefits are compounded at the social time preference rate ( $r$ ) and the reinvested benefits at the opportunity cost rate ( $P$ ). Both  $r$  and  $P$  are yet to be discussed.

<sup>9</sup>"Normalised" present value is defined as terminal value of the benefits discounted at *any* discount rate; whereas, "normalised" IRR is defined as that discount rate which makes the terminal value of the benefits just equal to the present value of the costs.

## B THE SOCIAL RATE OF DISCOUNT

Whatever investment criteria is adopted one of the most difficult problems is to determine the social discount rate. The discount rate has a critical effect on the evaluation of a project and may make the difference between acceptance and rejection. A project which seems worthwhile at 5 percent rate may appear extremely wasteful at a higher rate (e.g. 8 percent). There is considerable disagreement over its choice. In general three types of discount rates have been advocated: social time preference rate (STPR), social opportunity cost (SOC), and some combination of the two. Social time preference rate reflects the relative valuation which society puts on consumption at different periods of time, whereas social opportunity cost represents the rate of return forgone on the displaced project in the private sector when funds are transferred to the public sector. Irving Fisher demonstrated that, in equilibrium, the social time preference rate would be equal to the opportunity cost rate. Unfortunately under real world conditions, equilibrium of this kind does not prevail<sup>10</sup>. Hence there remains the acute problem of finding a figure for the discount rate.

### Social Time Preference Rate (STPR)

The search for rules to derive a perfect social time preference rate is futile. It is a normative function. Nevertheless, it is useful to examine the factors that must be considered in formulating a social time preference rate and to understand why such a rate is necessary. The use of market rates to reflect STPR is straightway rejected because of numerous imperfections prevalent in the capital market.

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<sup>10</sup>Some of the reasons for divergence between rate of return on private investment and social rate of time preference are discussed in Baumol [1968].

Now if a perfectly functioning capital market is assumed, will market rates reflect social time preference? McKean [1958, pp. 76-81] believes that in the absence of capital rationing, the market rate is an appropriate discount rate. However many writers consider this rate as inadequate and believe that social time preference attaches more weight to the future than private time preference. Ramsey [1928, p. 543] believes private time preference discounting as "a practice which is ethically indefensible and arises merely from weakness of the imagination". Pigou [1932, pp. 24-30] and Dobb [1955, pp. 70-74] also allege that individuals often under-estimate the pleasure which future consumption will in fact give them as they are victims of "defective telescopic faculty", and therefore, government intervention may be needed to give adequate weight to the welfare of unborn generations. In fact, Ramsey, Pigou and Dobb's view suggest that the relevant discount rate is best obtained from government as representative of society in its collective sense. Feldstein [1964, p. 367] also holds somewhat the same view.

Eckstein [1958, p. 100] on the other hand, rejects the market interest rate on the grounds that, "our notion of efficiency is relative to the distribution of income; should we seek to redistribute income to future generations, the interest rate loses its meaning as an efficient price". Another argument put forward by Sen [1961, p. 488]<sup>11</sup> and Marglin [1963a, pp. 98-99] relates to a special kind of externality. It is that people's preferences expressed as individuals may differ from their preferences expressed when they see themselves as part of a community. In other words, they may be willing to save for future generations if they are sure that others will act similarly. Social

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<sup>11</sup>A.K. Sen refers to this problem as the "Isolation Paradox". Later on, he reformulated the concept in a more general form in Sen [1967, pp. 112-15].

time preference rate will not, therefore, be some average of individual time preference rates derived from self-interested behaviour.

Since, by observation future preferences for a given dollar's worth of consumption are less than present preferences, a discount rate based on the diminishing marginal utility of consumption seems justified. It can be shown<sup>12</sup> that

$$r = \left( \frac{1 + k}{1 + n} \right)^e - 1$$

where  $r$  is the STPR,  $k$  is the rate of growth of total consumption,  $n$  is the rate of growth of population and  $e$  is the elasticity of the marginal utility function. Detailed and extended derivations can be found in Eckstein [1957, pp. 74-83] and Feldstein [1965, pp. 278-86]. The faster the rate of growth of the economy, the higher will be the appropriate discount rate. But it is difficult to judge how  $e$  and  $k$  will be determined.

#### Social Opportunity Cost (SOC)

Many economists, reject the relevance of the STPR to public investment decisions on the ground that resources are limited and their use in the project involves their withdrawal from some other potential use. The foregone expenditure is usually assumed to be the investment in the private sector. Therefore, "The correct discount rate is the percentage rate of return that the resources utilized would otherwise provide in the private sector"<sup>13</sup> [Baumol, 1969, p. 203]. For example, if the private investment can earn a rate, say  $P$ , then the public investment is not justified unless it too earns a rate of  $P$  or more.

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<sup>12</sup>Dasgupta & Pearce [1972, p. 144].

<sup>13</sup>This view is also supported by Stockfish [1969, p. 187] and Harberger [1972, pp. 31-32].

P is the true social opportunity cost and therefore, the relevant discount rate.

Now comes the problem of determining P. Numerous rates of return are observed in the private sector due to the absence of equilibrium in the economy and the presence of different risk aversions [Stockfish, 1969, p. 193]. Since public investments are considered to be of low risk, it is generally suggested that P should be calculated as a rate of return on comparable low-risk projects in the private investment, adjustment being made for any differences in the tax treatment and external effects. According to UNIDO Guidelines [1972, pp. 163-64], the use of such a rate as the relevant social discount rate is justified only under conditions of optimal growth and such optimality rarely exists in the real world conditions.

#### Average of STPR and SOC

The most general case is where the government has some financial constraints but it does have the power to alter the overall rate of investment in the economy. Under such conditions, some writers favour the weighted average of the two discount rates i.e. STPR and SOC. Marglin [1963b, pp. 279-80; 1967, pp. 54-56] has developed a method based on the manner in which the public investment is financed i.e. allowing for the fact that public investment may be partly at the cost of private investment and partly at the cost of private consumption. The forgone investment would have yielded the rate P(SOC), and the forgone consumption, a rate r (STPR). Now if the fraction Q of public investment comes out of private investment and the fraction (1 - Q) out of private consumption (assuming the inequality  $0 \leq Q \leq 1$ ), the weighted average rate of return ( $r_w$ ) forgone to finance public investment, therefore, would be

$$r_w = Q \frac{P}{r} + (1 - Q)$$

If public investment draws resources that would otherwise be unemployed, its opportunity costs may be smaller. Earlier, a somewhat similar approach was suggested by Steiner [1959, pp. 896-902] in the field of water resources.

Baumol [1968, pp. 790-92] criticizes the above approach by arguing that the method of financing an investment is irrelevant. If consumption is sacrificed, it could have been invested at the rate  $P$ . He expresses a strong preference for using the social opportunity cost rate ( $P$ ), with the reservation that investment in conservation projects should be deliberately encouraged, not by lowering the discount rate but by a set of selective subsidies [p. 801]. Mishan [1975, pp. 212-18] has also argued in favour of using the social opportunity cost rate ( $P$ ), provided there is no political constraint and the government is free to invest in the private sector. Harberger [1972, p. 39] fears the above approach may lead to situations where the rate of return to investment in the public sector lies below that of private sector. "Future generations lose, rather than gain, if funds are used for a 5 percent public-sector investment rather than for a 10 percent private-sector investment".

So far it has been assumed that investments merely "throw-off" consumption benefits. In practice both consumption and savings are likely to be yielded. If savings are sub-optimal, as is usually the case in developing countries, reinvested benefits (i.e. savings) are worth more than benefits which are consumed. So the decision rule becomes,<sup>14</sup>

$$\frac{C_t}{r} + \frac{a_0 S_t}{P} > K$$

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<sup>14</sup>See Dasgupta & Pearce [1972, p. 152].

where  $C_t$  is the benefit from a consumption flow in year  $t$ ,  $S_t$  is the benefit from savings flow in year  $t$ , and " $a_0$ " is the weight (the shadow price) attached to the savings flow. Thus, the existence of a savings constraint requires that consumption benefits be discounted at  $r$  (STPR) and the savings benefits be discounted at  $P$  (SOC).

Little & Mirrlees [1968, pp. 41, 178-79] also favour the above approach and have developed their model essentially along the same lines in the context of the Indian economy but by using savings as the numeraire and thereby penalizing consumption. They also allow for the possibility that  $P$  and  $r$  would change over time and optimally tend to converge. "In the face of the process of convergence, it is difficult to avoid the conclusion that some combination of the two rates is required" [Dasgupta & Pearce, 1972, p. 155].

#### Other Approaches

The UNIDO Guidelines [1972, p. 167] have approached the problem in a unique way by treating the social rate of discount as an unknown parameter of the project evaluation. This "switching value" (as it is called) of the social rate of discount is nothing but the project's internal rate of return. Note here, unlike the conventional use of internal rate of return, it is not to be compared with any predetermined bench mark. The only bench mark is the intention of policy makers which may be quantified with the aid of these switching values or internal rates of return.

Recently, a new approach to the social rate of discount has been developed by Scott [1977]. It links the discount rate to the notion of base-level income, where the base-level income is defined as that level at which the government is indifferent between marginal gains accruing to persons with base-level income and marginal gains accruing to itself. Symbolically, the discount rate ( $r'$ ) is

$$r' = n \left( \frac{\bar{b}}{b} \right) + r$$

where  $\frac{\bar{b}}{b}$  is the proportionate rate of growth of real base-level income,  $n$  is the elasticity of social weight given to marginal increases in income with respect to changes in income, and  $r$  is the pure rate of time preference [p. 219].

Following the above discussions, it can be concluded that choice of a discount rate is purely a value-judgement and there are no clear-cut rules for its determination. "But if this is so, does it not reduce the whole process from an exact science to an "art" dependent on personal judgement, preferences and perhaps prejudice?" [Peters, 1973, p. 25].

CHAPTER 4RISK AND UNCERTAINTY

In previous chapters it has been assumed that decisions are made under "certainty". However the fact that projects deal with events in the future, inevitably means that risk and uncertainty of varying degrees will be involved. The various ways in which these risks and uncertainties enter into economic decisions are discussed by many writers<sup>1</sup> but their implications for the public sector remain highly controversial. It is widely accepted that individuals are averse to risk and to anyone who is in this situation, a certain prospect of receiving \$X is worth more than a fifty-fifty chance of \$0.5 X and \$1.5 X. Therefore, private investors do not choose investments to maximise the present value of expected returns, but to maximise the present value of returns properly adjusted for risk. The issue is: should the public sector follow suit?

It is argued that the government invests in a large number of diverse projects and is, therefore, able to "pool" risks. This argument has led many writers [Little & Mirrlees 1968, pp. 96, 191; Harberger 1972, pp. 64-65; UNIDO Guidelines 1972, pp. 110-12] to suggest that risk can be ignored in cost-benefit analysis. If an unexpected failure of one project is matched by extra-ordinary success in another, then an additional project can be treated as if it had zero risk. The only exception is when the project is too large in relation to the whole economy, otherwise the assumption that the government should be neutral towards risk appears quite reasonable.

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<sup>1</sup>McKean [1958, pp. 64-71]  
Eckstein [1958, pp. 81-90]  
Hirshleifer [1965, pp. 531-34; 1966, pp. 254-64]

Arrow & Lind [1970, pp. 370-73] have given a different reason for ignoring risk on public projects. They convincingly argue that since the risks associated with a public investment are borne by a large number of people (the tax-payers), the total cost of risk-bearing is insignificant. As the number of tax-payers tends to infinity, the cost of the risk tends to zero because the share borne by each tax-payer becomes a negligible component of his income. In cases where a project affects a small group, when each individual bears a significant proportion of risk, it is appropriate to make allowance for risk [p. 377].

The view that public projects should allow for risk is most strongly advocated by Eckstein and Hirshleifer. "While some of the risks of private undertaking are eliminated on public projects, or at least are much less, ----- and even if we assume that government attitudes toward risks differ from those of management, it would be folly to ignore them altogether" [Eckstein, 1958, p. 81]. Hirshleifer [1966, pp. 270-75] argues that pooling itself may not be desirable and may reduce the value of the total package of investments. Further if ignoring risk in the public sector entails using a discount rate which is lower than rates in the private sector, it will lead to the displacement of private investment by public investment yielding lower expected returns. ODA Guide [1972, p. 33] also asserts the importance of risk analysis in the public sector for good decision making.

Then there are others<sup>2</sup> who do favour making allowances for risk in the public sector but reject the notion of using individual risk aversions as revealed by market behaviours. They stress that risk

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<sup>2</sup>This point is discussed in Arrow & Lind [1970, pp. 364-64].

preferences, relevant to government action, should be established as a matter of national policy.

The issue remains controversial; there appears to be no consensus among the different schools of thought. Certainly, if risk can be ignored either because of risk-pooling across projects or because of risk-spreading across the public, the problems of cost-benefit analysis can be simplified to a great extent. However if risk is relevant to cost-benefit analysis, then the problem is how best to allow for it. Eckstein [1958, p. 90] proposes the addition of a "risk premium" to the discount rate and considers it to be the most useful adjustment for risk in project evaluation. Hirshleifer [1961, pp. 118-19] also supports this view. The procedure amounts to calculating the present value of the investment project using a rate of discount that is larger than the basic rate of discount used for riskless projects i.e. the discount factor becomes

$$d_t = \frac{1}{(1 + r + a)^t}$$

where "a" is the risk premium. This approach is considered appropriate where uncertainty is a strictly compounding function of time. It is severely criticized by Henderson [1968, p. 141], who described it as a "very crude expedient". He argues that there is no particular reason<sup>3</sup> for supposing risk will behave in this orderly fashion and moreover, it provides no guidelines for how this risk-premium is to be estimated. Marglin [1963a, p. 96] also considers adjustment in the discount rate as an inappropriate means of dealing with uncertainty.

Another way to deal with risk is to reduce the planning horizon

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<sup>3</sup>

According to Eckstein [1958, p. 88], technological change is the biggest source of risk for long-range projects and historical experience has shown that there is a *steady rate of advance* in technology; the project becomes more and more obsolete as time passes.

of the project i.e. to shorten the period of analysis. In this procedure, no credit is given to benefits which accrue after the cut-off date. Where the main risk is likely to be "a sudden day of reckoning when benefits disappear or costs soar" [Prest & Turvey, 1965, p. 699], this method is recommended. But a project which is safe to a certain date and extremely risky thereafter will be treated at par with a project which has the same degree of safety to the cut-off point but no risk thereafter. Obviously the latter project is more desirable than the former especially if the risk of disaster is high. Moreover, since this method penalizes projects with longer economic life, it contradicts the rationale of government undertaking projects for future generations [Eckstein, 1958, p. 86].

One more technique to allow for risk is the practice of safety allowances - a flat percentage increase of costs or decrease of benefits. On the cost side, it takes the form of contingency allowances especially in the estimation of construction costs. It is widely practiced by businessmen in the private sector. On the benefit side, conservatism in projecting future output prices is the usual type of safety allowance. The difficulty arises as different safety allowances are needed for different types of projects and it is not clear how such allowances are to be derived.

In a situation where risk is irregularly distributed over time the probability approach is most appropriate. Statistical techniques can be used to establish probability distribution. One simple procedure is to take the mean of the distribution as the appropriate value to be entered into the cost-benefit analysis. This mean is known as the "expected value" of the variable. In symbols: if a variable  $X$  can take the values  $x_1, x_2, x_3, \dots$ , its expected value is defined as  $P_1x_1 + P_2x_2 + P_3x_3 + \dots$ , where  $P_i$  is the probability of taking the value  $x_i$ . Often it is pointed out that

the use of "expected value" does not really make allowance for risk, since two distributions can have the same mean but significantly different dispersions. In defence, it is argued, for society as a whole when all projects are taken together, the dispersions from expected values of individual project benefits will tend to cancel out to some extent<sup>4</sup>. Thus the expected value criterion gives the correct decision rule for cost-benefit analysis. On the other hand, if dispersion is also included, many approaches are possible such as "certainty equivalent", "gambler's indifference map" and so on<sup>5</sup>. Then the analysis becomes too complicated and vague leaving little practical use.

Situations may exist where it is not possible to assign any probabilities at all to the outcomes of a project. This provides a case of what Knight called uncertainty and here the only approach that is relevant is the theory of games. A number of different decision criteria based on this approach have been suggested. The standard ones are (a) maximin pay-off (Wald) criterion, (b) minimax regret (Savage) criterion, (c) index of pessimism (Hurwicz) criterion and, (d) principle of insufficient reason (Laplace) criterion.

The maximin (Wald) principle is appropriate for the pessimist. He guards against the worst possible outcome from each strategy. Whereas the minimax regret (Savage) criterion is suited to a cautious planner who wishes to minimise the degree of error he might commit. Both criteria are concerned exclusively with maximising security and are therefore

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<sup>4</sup>It is true the "expected value" criterion does not accord a premium for undue risk. In the face of uncertainty, the valuation of costs and benefits in terms of their expected value is suggested by those writers who are against government making allowance for risk. As mentioned earlier, they justify it on the basis of "pooling of risks" argument.

<sup>5</sup>The various approaches are discussed by Dorfman [1962, pp. 145-52].

exceedingly conservative. They differ only in offering different interpretations of what maximum security means. In addition, Dorfman [1962, pp. 131-34] demonstrates how some irrelevant considerations can alter the ranking obtained by these criteria and thereby lead to illogical conclusions.

The Hurwicz principle suggests that decision should be based on both the "best" and the "worst" outcomes. The appropriate weights to be assigned to these outcomes depend upon the degree of pessimism of the individual. On the other hand, the Laplace criterion places equal weights on each outcome on the grounds that there is no particular reason to suppose that they are different in any way. In fact "there is no dearth of decision criteria for dealing with 'pure uncertainty'. Unfortunately, none of them appears to be particularly satisfactory" [Dasgupta & Pearce, 1972, p. 191]. Thus the problem of uncertainty remains uncertain.

If none of the above suggestions appears to be practicable, it is always advisable to carry out sensitivity analysis with respect to variables of the major sources of uncertainty. Its relevance to cost-benefit analysis is strongly advocated by ODA Guide [1972, pp. 25-26]. Sensitivity analysis shows how net present value varies with changes in the uncertain variable and thereby indicates areas where further studies designed to reduce risks may be worthwhile. There is no point for example in paying undue attention to an item which has negligible effect on NPV. In addition, sensitivity analysis gives a clue to the range of project performance that can be expected.

## CHAPTER 5

WELFARE CRITERIA AND INCOME DISTRIBUTION

As mentioned earlier, the objective of cost-benefit analysis is to help the government to single out those projects for implementation that would contribute most social net benefits i.e. maximise social welfare. In order to assess the impact of a project on society, it is essential to find out how the project would effect the welfare of each individual concerned. To judge this effect, it is necessary ultimately to rely on the individual's own evaluation i.e. to measure the change in his welfare as he himself would value it<sup>1</sup>. This is equivalent to saying what he would be willing to pay to acquire the benefits or to avoid the costs - a change in consumer's surplus. Now suppose that the effect of undertaking a project is to decrease the price of a commodity from  $P_1$  to  $P_2$  as shown in Figure 4. The

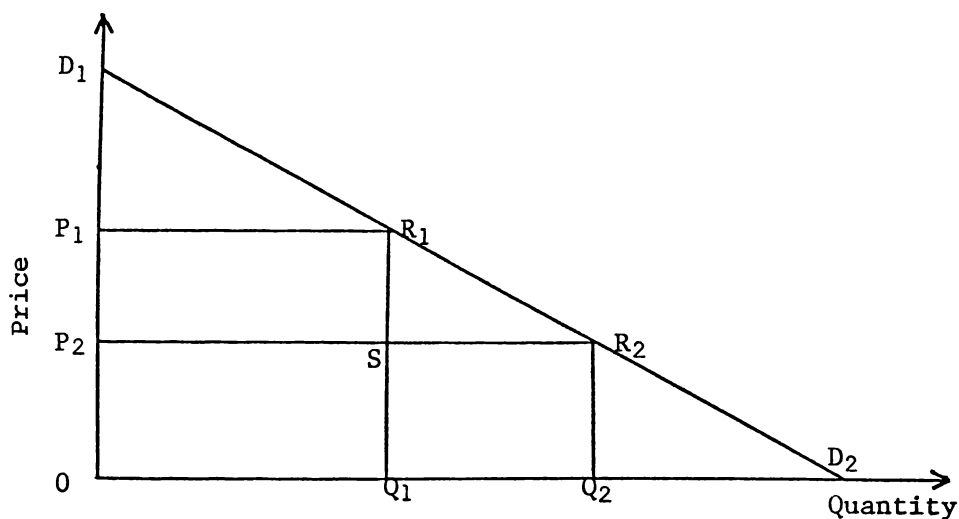


Figure 4. Consumers' surplus

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<sup>1</sup>This is the utility base of welfare economics; for a distinction between utility base and ethical base refer Mishan [1975, pp. 386-89].

The area  $P_1 P_2 R_2 R_1$  shows the gain in consumers' surplus. Marshall adopted this gain in consumers' surplus as a measure of welfare gain subject to the assumption that the marginal utility of income did not change as a consequence of the change in price of any commodity.

The gain in consumers' surplus can be split into two parts. The first component,  $P_1 P_2 SR_1$ , known as the cost-saving component, is the result of reduction in price,  $P_1 P_2$ , on the original quantity purchased,  $OQ_1$ ; whereas the second component,  $SR_1 R_2$ , is the consumers' surplus due to the additional purchases made,  $Q_1 Q_2$ , either by the same persons or by additional persons. In a special case (as assumed above), where the demand curve is linear, the change in consumers' surplus can be calculated as:

$$\begin{aligned} \text{Change in CS} &= \text{Area } P_1 P_2 SR_1 + \text{Area } SR_1 R_2 \\ &= P_1 P_2 \cdot OQ_1 + \frac{1}{2} \cdot P_1 P_2 \cdot Q_1 Q_2 \\ &= \Delta P \cdot OQ_1 + \frac{1}{2} \cdot \Delta P \cdot \Delta Q \\ &= \Delta P(OQ_1 + \frac{1}{2} \Delta Q) \end{aligned}$$

this is a formula which is often used in cost-benefit analysis, especially for small changes in prices, when the demand curve can be reasonably approximated as linear [Mishan, 1975, pp. 27-29; George & Shorey, 1978, pp. 48-50].

The next step is to derive the change in social welfare implied by all the changes in individual welfare. Here cost-benefit analysis gets entangled with ethical judgements. It is not possible to aggregate the welfare of individuals without referring to society's approach to the problem of income distribution. If income were equally distributed, a dollar more or less would be equally valuable regardless of whose it was, so that each man's dollar has equal weight. But if

income is not equally distributed, it seems justified to value the poor man's dollar more highly than the rich man's<sup>2</sup>. One approach suggested to resolve this problem is the principle of compensation. It is closely connected with the concept of Pareto optimality which lies at the heart of cost-benefit analysis. A Pareto improvement is defined as a change in economic organization that makes one or more members of society better-off without making anyone worse-off. In a broader sense (Kaldor-Hicks version), it means a change such that gainers can - through costless transfer - fully compensate all the losers and still remain better off themselves than before. If the very restrictive Pareto criterion of a welfare improvement is applied, a project will be supported only if some people gain and nobody loses. In practice there is almost no case where no one is made worse-off, and if this restrictive Pareto rule were applied, no project would ever be implemented.

The Kaldor-Hicks<sup>3</sup> principle of compensation makes an attempt to preserve the concept of Pareto optimality, while making allowance for this obvious fact of life that most, if not all, economic changes do involve losses for some people and gains for others. In simple terms, the principle requires only that the gainers be able to compensate the losers (even if in practice they do not) and still have some gain left over for themselves. If this is possible i.e. the value of benefits exceeds the value of costs, the project under consideration

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<sup>2</sup>Robbins [1938, pp. 635-41] is very critical of the assumption that all human beings have equal capacity for satisfaction. He argues that this assumption rests upon ethical principles rather than upon scientific demonstration and is therefore outside the domain of economics.

<sup>3</sup>Kaldor [1939, p. 550]  
Hicks [1939, pp. 706-12]

will still generate a Pareto improvement because the compensation paid to the losers (those who bear the costs) leaves them no worse-off than before. Harberger [1971, pp. 785-86, 795] strongly pleads in favour of this potential Pareto improvement criterion, embodied in the Kaldor-Hicks compensation test, to have consistency in project evaluation. Mishan [1975, p. 390] also justifies the use of this criterion although it corresponds to a single provision of the "virtual constitution" of the society. But what is the ethical justification in the absence of compensation?

There is also the problem of the Scitovsky paradox. He [1941-42, pp. 83-88] demonstrates<sup>4</sup> that under certain circumstances, it is possible for the gainers to persuade losers to accept a change and for the losers to persuade gainers to move back to the status quo once the change has occurred. In fact what happens is that the change is desirable when valued at the prices prevailing in the initial state but undesirable when valued at the new set of prices prevailing in the new state. In the process relative prices get altered because of the redistribution of income that emerge from the change. But Mishan [1975, p. 396] argues that while this apparent paradox is obviously a disconcerting theoretical possibility, in the real world such possibility diminishes as the focus of analysis gets narrowed thereby distributional effects become smaller. Nearly all cost-benefit calculations can be regarded as exercises in very partial analysis, and all prices, outside those pertaining to the project, may be reasonably assumed as constant. In short, the compensation principle requires that cost-benefit analysts should confine themselves only to those procedures that are consistent with the efficiency criterion. It implicitly assumes that the

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<sup>4</sup>This demonstration is given in many text-books as well.

prevailing distribution of income is socially approved<sup>5</sup>. If the project has any undesirable distributive consequences, these can be off-set by lump sum transfers to compensate the losers.

The assumption that any unfavourable effects of a project on income distribution can be neutralized by compensation is rarely applicable in practice. Income transfer devices are not costless to undertake. In fact redistribution may not be possible at all by lump sum transfers due to political objections and administrative difficulties. Even if it is feasible, society may itself express a view as to how redistribution is to be instrumented. As Marglin [1962, p. 63] points out "the size of the economic pie and its division may not be the only factors of concern to the community - the method of slicing the pie may also be relevant". If compensation to off-set the losses due to the project is not effective it seems justified that distributive effects should be considered along with efficiency measures.

Many authors prefer to exclude income distribution from formal efficiency criterion. Musgrave [1969b, pp. 804-05] argues that projects should not be used as instruments for distributional changes. Indeed, it is more efficient to redistribute income directly through government programs of taxation and subsidies. One should therefore, judge projects on efficiency grounds and leave the government to ensure through fiscal policies that distribution is fair. But it is often pointed out that taxes and subsidies distort incentives and thereby lead to misallocation of resources. Another argument<sup>6</sup> which justifies ignoring distributional effects, rests on the grounds that the change

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<sup>5</sup>It is justified on the ground that individuals are paid according to their marginal product which reflects their contribution to society; people deserve rewards equal to their contribution and therefore the income distribution is fair.

<sup>6</sup>This view is referred to in many text books such as Dasgupta & Pearce [1972, p.62].

in income distribution due to a single project is negligible and therefore inconsequential. Further since government undertakes a large number of diversified projects over time, the overall distributional effects are almost neutral as losers get compensated automatically. However, Nash, Pearce & Stanley [1975, p. 127], are very sceptical of this view as they state, "We know of no empirical testing of this hypothesis, which seems highly implausible, at any rate for schemes such as transport projects which have geographically highly localised costs". In other words, many projects are large and tend to be localised having significant distributional consequences.

Because of the reasons discussed above, the income distributional aspect of the projects has recently attracted a lot of attention. As Little [1957, p. 100] pointed out sometime back, an improvement in efficiency is a necessary but not a sufficient condition for a project to be socially approved. In addition it must be shown that the resulting distributional effects are not regressive. Many writers<sup>7</sup> have come to support this idea and suggest that cost-benefit analysis should have a wider criterion for project selection - a criterion in which the changes of income to each of the parties effected can be allowed for. Now the real problem is how such changes can be incorporated into the criterion? Two approaches are suggested. Distributional effects may be included in the criterion firstly by explicitly using some distributional weights and secondly by specifying constraints on income distribution.

One simple method to obtain distributional weights ( $W_i$ ) is suggested by Foster [1966, pp. 314-15]. According to him each gain or loss

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<sup>7</sup>Such as Eckstein [1961 (Reprinted 1970, pp. 223-26)]; Marglin [1962, pp. 62-86] and Weisbrod [1968, pp. 177-209].

should be weighted by the ratio

$$W_i = \frac{\bar{Y}}{Y_i}$$

where  $\bar{Y}$  is the average personal income for the nation, and  $Y_i$  is the personal income of the  $i$ th individual or group. Obviously the idea is based on the moral notion that "willingness-to-pay" should be measured as if there is equitable distribution of income in society. However, it involves the "problem of piecemeal planning" [Nash, Pearce & Stanley, 1975, p. 130]. Moreover "the method requires acceptance of a general rule of justice which has not been legitimised by any social practice ----- it would be enormously difficult - impossible surely - to get the idea accepted" [Self, 1975, p. 142].

Some writers suggest that weights can be derived from the political process. Maass [1966, p. 210] points out that legislative process has the capacity to make trade-off decisions between efficiency and income redistribution. Weisbrod [1968, pp. 190-208] has illustrated a method with the aid of equations to derive weights for different income groups from the government's past decisions. However there is an obvious objection to this approach. If the government's decisions so far have been correct, why is cost-benefit analysis needed to validate it. On the other hand if they have been incorrect, what is the justification of carrying out distribution in the same way? Indeed Ruth Mack<sup>8</sup> argues that the suggested framework of Weisbrod's method is inapplicable to the world in which policy decisions are actually made. Haveman<sup>9</sup> too, has reservations about this method. He points out that decisions are usually based on a number of considerations other than income distribution.

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<sup>8</sup>In a comment to Weisbrod's paper [1968, p. 219].

<sup>9</sup>In a comment to Weisbrod's paper [1968, pp. 209-10, 213].

But he concludes that the analysis does point the way to general methods of deriving weights and further efforts should be made in this direction.

Eckstein [1961 (Reprinted 1970, p. 224)] favours the use of marginal rates of income taxation to derive such weights. The relevant weights would simply be the inverses of the marginal income tax rates. Since the marginal rate tends to rise as income rises, it would appear that society implicitly assigns lower weights to benefits accruing to a richer person than to a poorer person. The trouble with this method is that an equity judgement is only one of many factors that enter into income tax determination. Moreover indirect taxes also partly reflect this judgement as luxury goods are taxed higher than necessities. Why ignore them? One more method of deriving these political weights is suggested by UNIDO Guidelines [1972, p. 104]. It is a more direct and explicit approach, suggesting that government should determine the relative weights for redistribution on the basis of some poverty line. In practice it is not easy to discover a government's preferences. Mishan has a very poor opinion about all these politically determined weights. He strongly denounces them and passionately pleads in favour of a potential Pareto improvement criterion<sup>10</sup>. Perhaps he inherently dislikes the idea that 'the government always knows best'. Others suggest that relevant weights can be derived from the assumed elasticity of the marginal utility of income. But the big question remains - who determines the elasticity: government or the economist?

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<sup>10</sup>For his detailed criticism of the politically determined weights and the arguments in favour of a potential Pareto improvement criterion, see Mishan [1974, pp. 89-94].

In case no distributional weights can be assigned, Marglin [1967, pp. 24-25] suggests approaching the problem in a slightly different way by specifying a constraint on the objective function. In this method total benefits may be maximised subject to the constraint that some minimum benefits must be secured by a particular income group or region. Alternatively, benefits to a specific group or region may be maximised subject to some minimum total benefits. The approach is not very different from that of distributional weights. Specification of constraint levels implies assigning weights to the benefits of a group under consideration relative to total benefits. However, this level is determined *ex post*, whereas the use of distributional weights in cost-benefit analysis is an *ex ante* concept.

Some<sup>11</sup> have even suggested making use of the "Planning Balance Sheet" as developed by Lichfield [1970] to avoid distributional pitfalls. In the absence of general consensus, it can be concluded that many cost-benefit analysts [notably Little & Mirrlees, 1968, p. 98] are still against the formal inclusion of distributional weights into the project criterion, although they strongly suggest that the analyst should show separately the incidence of costs and benefits on different groups in society so that the government can decide rationally and apply its own judgement. Obviously the distributional issue is not resolved and perhaps will never be.

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<sup>11</sup>Self [1975, pp. 144-45];  
Nash, Pearce & Stanley [1975, p. 132].

CHAPTER 6CONCLUSION

The past two decades have witnessed a tremendous growth of interest in cost-benefit analysis and the technique has been applied to a wide range of projects. A number of doubts have been expressed about its role and usefulness, which is hardly surprising in the light of the problems discussed above. Some consider the technique no more than a desire to introduce a semblance of rationality into the huge government spending, perhaps to buttress decisions against critical assault. Peter Self<sup>1</sup> [1970, p. 249] has even gone to the extent of calling the methodology of cost-benefit analysis as applied by the Roskill Commission [1970 & 1971] as "nonsense on stilts". Others argue that there are too many unknowns and assumptions. Hammond [1966, p. 219] puts it sarcastically that the technique is "a veritable jungle of assumptions, postulates and formulae, of entities multiplying incessantly and without limit in the name of economic efficiency, while administrative efficiency is left out of account". The technique is not able to prove, even in theory, all that has been claimed for it. No consensus has been reached in identifying the costs and benefits, in making allowances for market imperfections and externalities, in choosing an appropriate discount rate, in making adjustments for uncertainties and so on. Further, ethical objections are also raised against cost-benefit analysis for its failure to trade-off between efficiency and other objectives such as income distribution. It appears that many analysts believe that by concentrating on efficiency criteria, they can avoid the need to make value judgements.

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<sup>1</sup> Later on, however, he admitted that his criticism was somewhat exaggerated [Self, 1975, p. 173].

But Hammond [1966, p. 218] says cost-benefit analysis is not merely "unable to replace judgement in the making of decisions, but it depends at every point on judgement in the choice of assumptions. It is the creature of policy and to treat it as a determinant of policy is to argue in a circle".

Now the question arises, is there a better alternative?

Decisions have to be made both for those projects carried out by the public sector itself and those in the private sector which are subject to government permits or licences. Decisions are also needed for those private projects which require some kind of government assistance, such as tariff protection, tax relief, foreign exchange allocation etc. Thus, in practice, a substantial number of, if not all, projects require government approval. Leaving government to decide on a commercial basis means not recognising the problem of externalities, market imperfections etc. Alternatively can the government be left to rely on its hunch, guesswork or horse trading? Pulling some arbitrary 'requirement' or 'priority' out of a hat is not the right way to make decisions [McKean, 1963, p. 35]. Cost-benefit analysis, at least, forces the authorities responsible to quantify costs and benefits as far as possible. Some information is always better than none. It is pointed out that quantitative analysis often leads to better decisions than rules of thumb. However rough the estimates of benefits are, they do provide some clue to the consumer's willingness to pay. Sometimes, cost-benefit analysis plays purely the negative role of screening projects and rejecting those which are obviously inferior. It is thus capable of helping the government to get more from the available resources. Williams [1972, p. 210] has remarked on the usefulness of cost-benefit analysis as: "It is thus systematic, quantitative and communicable and hence an improvement upon the

casual, implicit and possibly capricious evaluation that can so easily be concealed if such matters are left to piecemeal informal judgement *on their merit.*"

Peters [1973, p. 71] is of the opinion that it is too early to say anything on the usefulness of cost-benefit analysis, but because of its inherent limitations, it is certainly not a technique that "can simply be 'switched on' in the hope that it will provide an unequivocal solution to a problem". But it should be remembered that tools do not have to be perfect in order to be useful. As Prest & Turvey [1965, p. 73] earlier concluded "the case for using cost-benefit analysis is strengthened, not weakened, if its limitations are openly recognised and indeed emphasised". The controversy over the usefulness of cost-benefit analysis may be summarised in Maurice Chevalier's reply to an interviewer who asked him how he viewed old age: "Well, there is quite a lot wrong with it, but it is not so bad when you consider the alternative".

PART TWO

A CASE STUDY:

A PROPOSED FREEZING WORKS IN

HAWKE'S BAY

CHAPTER 7

INTRODUCTION

The Meat Industry in New Zealand

The meat export industry has existed in New Zealand for nearly 100 years - the first shipment of frozen meat from New Zealand being made in 1882 [Critchell & Raymond, 1912, p. 41]. Ever since it has contributed significantly to the prosperity of this country. In the year ended June 1978, the industry accounted for more than 34 per cent (Table 1) of New Zealand's export receipts, maintaining its position as the country's major export earner. Its dominant share of export earnings

Table 1. New Zealand Export Receipts

(Year Ended June 1978)

Export	\$ million	%
Meat Industry	1,174.7	34.4
Wool Industry	619.2	18.1
Dairy Industry	619.8	18.1
All Others	1,005.0	29.4
<b>Total</b>	<b>3,418.7</b>	<b>100.0</b>

Source: Calculated from Reserve Bank of New Zealand Bulletin.

compared with other principal industries is depicted in Figure 5.

With the country's Balance of Payments position of such concern<sup>1</sup> and to meet the increasing demand for imports in order to maintain the living standard of New Zealanders, it is imperative that all sources of increasing export earnings be sought.

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<sup>1</sup>The current account deficit reached over 13 per cent of Gross National Product in the year ended March 1975. It was 4.5 per cent of Gross National Product in 1978.

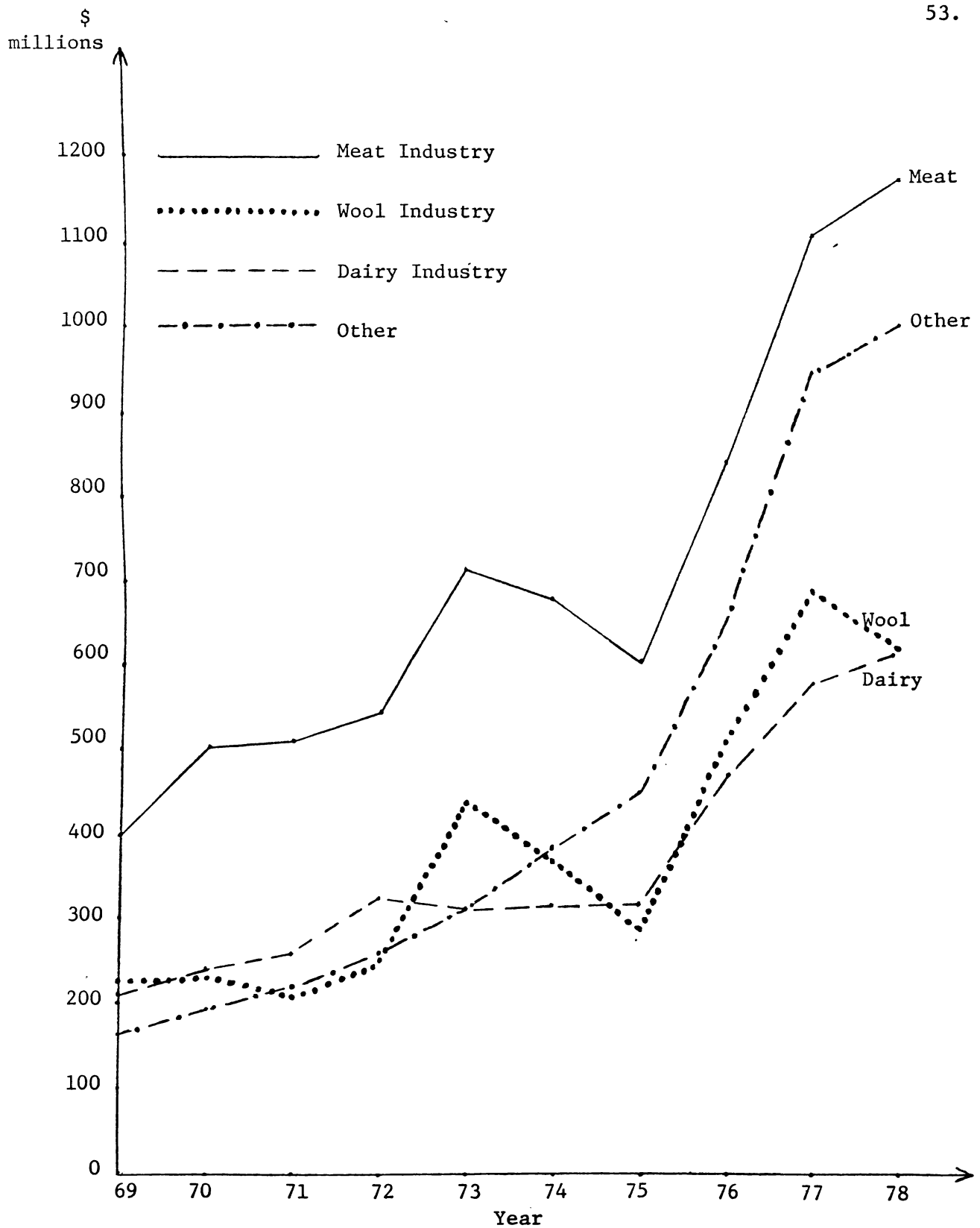


Figure 5. New Zealand export receipts - principal industries (year ended June 30)

Source: Appendix 1

Looking at the magnitude of the total contribution made by the meat industry (Appendix I), it is important that resources used to stimulate the production of export income should not be channelled away from this major industry. The Task Force Report [1976, p. 281] states that, "agriculture has been the driving force in the development of New Zealand and in the medium-term future the bulk of New Zealand's foreign exchange must still come from agriculture".<sup>2</sup>

The New Zealand meat industry has in the past clearly demonstrated its ability to grow and expand. Total meat production over the last four decades is shown below (000 tonnes):

1940's	-	565.6*
1950's	-	658.3
1960's	-	897.8
1970's	-	1105.5 <sup>#</sup>

\* 5 years average as statistics not available for the first 5 years

<sup>#</sup> period covering 1970-78

Source: Calculated from New Zealand Official Yearbook 1978.

Undoubtedly it still has the production potential on which the country can draw for future growth. However, as an exporter, success depends upon its ability to sell high quality and the right kind of meat at relatively low cost in overseas markets. This ability to produce at comparatively low cost was maintained over a long period of time, and in fact, the predominant factor of concern was the level of overseas prices. But now the situation is very different. The level of "on and off farm costs" i.e. production, processing, and transport costs - have reached critical levels. For example, production cost

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<sup>2</sup>

On the average over the last ten years, the agricultural sector has contributed 78 per cent of total export earnings, of which more than 38 per cent is that of meat industry's share.

alone has increased more than two and a half times over the last ten years<sup>3</sup>. These costs have a major impact upon New Zealand's ability to export. Mr Hilgendorf<sup>4</sup>, chairman of the Meat Producers Board, said, "Our overwhelming problems are internal. Our ability to produce enough meat at a reasonable price; to have it killed, processed and delivered on time; these are the things I find the most worrying aspects of the industry" (p. 7). On the whole, however, the meat industry is still efficient and given the opportunity, it has the ability and the capacity to expand.

#### The Meat Industry Authority

The Meat industry has attracted much government attention because of its national importance coupled with the problems it has been facing since the early seventies. Since 1973 government has set up three committees and commissions to comment on the different aspects of the industry.<sup>5</sup> The most weighty body to review its problems was the Nordmeyer Commission of Inquiry which reported in 1974. On its recommendation a Meat Industry Authority was established in 1976 by

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<sup>3</sup> Expenditure per stock unit was:	\$ 4.34 - 1967-68
	\$10.33 - 1976-77
	\$11.21* - 1977-78
	*Provisional

Source: New Zealand Meat & Wool Board's Economic Service.

<sup>4</sup>The extract of Mr Charles Hilgendorf's speech given at the mid-year meeting of the Board's Electoral Committee (1978) is published in "The New Zealand Meat Producers" September 1978, p. 7.

<sup>5</sup> (a) K.R. Congreve Report (1973)  
 (b) D. MacIntyre Report (1974)  
 (c) A.H. Nordmeyer Report (1974)

amendments to the Meat Act 1964. The Meat Industry Authority is responsible for making decisions concerning the future of all meat works in the country with a view to obtaining a more rational allocation of resources. If a new works is proposed, in considering whether it should be established or not and where it should be sited, the Authority<sup>6</sup> is required to follow the criteria set-out in Section 28(2) of the Meat Amendment Act 1976, which read as follows:

- "(a) Whether or not there is any economic need or justification for the proposed work in the area, having regard to the overall development on a national basis of economic and efficient stock-slaughtering and meat processing, chilling, freezing and storage facilities:
- (b) The effect of the proposed work, if undertaken, on the ability of other licensees of export slaughterhouses to obtain regular supplies of stock sufficient for the reasonable requirements of their business:
- (c) All such other relevant matters as the Authority thinks proper."

Since its inception the Authority has made decisions on a number of applications. Its most controversial decision in December 1977, was to decline to issue a licence for additional killing facilities in the Hawkes Bay region either to Hawkes Bay Farmers Meat Company Limited or to Pacific Freezing (NZ) Limited.<sup>7</sup> According to the Authority both

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<sup>6</sup>For the sake of simplicity, the word "Authority" will be used in place of "Meat Industry Authority".

<sup>7</sup>Most of the information on this section has been collected from the correspondence between the Meat Industry Authority and the companies concerned, submissions made to the Authority in support of respective companies applications, New Zealand Meat Producers Board, and various newspapers.

applicants failed to satisfy the criteria as laid down in Section 28(2) of the Meat Amendment Act 1976. When both applications were rejected, the disappointment among farmers was so great that a suggestion was made to delicense the freezing industry. The New Zealand Meat Producers Board<sup>8</sup>, on the other hand, suggested some broadening of the criteria under which the Authority is required to act. Following unsuccessful submissions, both companies re-applied for a licence to process sheep and lamb over which a decision is still pending. Hawkes Bay Farmers Meat Company Limited (HBFMC) proposes to have one new chain at Fraser Road, Takapau, together with an additional chain to be transferred from the Gear Meat Company Limited at Petone; whereas Pacific Freezing (NZ) Limited (Pacific) wishes to erect a new three chain works at Oringi near Dannevirke. A number of submissions supported by farming groups were made during the recent<sup>9</sup> public hearings in attempts to convince the Authority of the feasibility of their respective applications. However, lack of any clear-cut and standardized approach to evaluating projects in terms of their contribution to the national economy, has led to confusion and has made the task of the Authority all the more difficult. In this part of the thesis, an attempt is made to suggest such an approach.

#### Cost-Benefit Analysis

The basic economic problem facing all countries is that of allocating limited resources such as labour, capital, land and other natural resources to a variety of different uses such as current production of consumer goods and services or investment in infrastructure, industry, agriculture and other sectors of the economy. Using

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<sup>8</sup> The New Zealand Meat Producers Board (a) [1978, p. 7]

<sup>9</sup> Late 1978 and early 1979.

limited resources in one direction means reducing the availability of resources for another use. A choice has to be made among these competing uses of resources. For a private commercial firm such a choice is a relatively straight-forward exercise. But a project which needs government permits or licences requires double criteria to be satisfied, as often the aim of government control is to have a more rational allocation of resources in the national interest. In other words, the proposed project should not only earn an acceptable rate of return for the firm but should also be beneficial to the national economy. This requires a much more complex exercise than a feasibility analysis carried out from the firm's point of view and the techniques used in the latter exercise may not be helpful in the former. Cost-benefit analysis can be used to achieve such a national evaluation in a convenient and comprehensive fashion. The objective of cost-benefit analysis as mentioned earlier in Part One is to view the consequences of the project in the light of national interest. In essence, the method evaluates the costs and benefits of a project, and if benefits exceed costs, both expressed in terms of a common denominator, the project is acceptable; if not, the project should be rejected. In addition, it can be used to compare alternatives to identify projects with a larger surplus of benefits over costs. It should, however, be remembered that the twin objectives (i.e. the private commercial objective and the national objective) are not always attainable as the concepts used by accountants in calculating commercial profitability and by economists in calculating national benefits diverge widely.

The exercise of cost-benefit analysis followed in the subsequent chapters is carried out strictly from the nation's point of view.

It seeks to take into account the interest, although sometimes conflicting, of the various sectors of the economy i.e. the farmers, the freezing

companies, the exporters, and the transport industry. In simple terms the objective is to maximise the net national benefits.

It must be made clear at the outset that the purpose of this thesis is not to support or oppose either of the applicants (HBFMC and Pacific), but simply to suggest an approach that can aid the Authority in arriving at decisions more rationally and quickly in its capacity to issue licences within the freezing industry. The project as proposed by HBFMC has been chosen for the cost-benefit analysis in the light of the above objective. This choice has been made for various reasons. Both proposals (HBMFC and Pacific) refer to the same region. The reports on each site indicate that both are suitable for erecting freezing works facilities in terms of physical conditions, environmental impact, access to transport and services, water and electricity availability and so on. However, the nature of the applications differ substantially. HBFMS's proposal will create additional killing capacity equivalent to one chain (the second chain is only a transfer of capacity); whereas Pacific's proposal will create additional killing capacity equivalent to three chains. In the light of considerable differences of opinion<sup>10</sup> and in the nature of the project, it seems logical to pick a project for analysis that creates less additional capacity. However, the decisive factor was the availability of information. Very kindly access was given, on a strictly confidential basis, to HBFMC's costing figures and other relevant material through PA management consultants Limited.

In spite of the national importance of this industry and its currently being a topical issue among official circles, farmers, and freezing companies, there is virtually no accessible literature on the topic

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<sup>10</sup>Submissions made to the Authority during public hearings in 1977 as well as in 1978-79.

under consideration. In a bid to obtain the required information, various Statutory and Government Bodies, Local Authorities, Commercial Organisations as well as individuals connected with the industry have been personally approached. In summary, this study attempts to appraise the economic feasibility of erecting a new freezing works in the Hawkes Bay as proposed by HBFMC in cost-benefit terms, paying particular attention to its impact on farmers and freezing companies. Since the purpose of this thesis is only to suggest an approach to the Authority, no attempt has been made to do a comparative study of the two proposals.<sup>11</sup>

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<sup>11</sup>Since the nature of the two proposals differ substantially, a lot more information is required to do a comparative study and is outside the scope of this thesis.

CHAPTER 8THE COMMERCIAL FEASIBILITY STUDYIntroduction

The Hawkes Bay Farmers Meat Company Limited (HBFMC) has applied for a licence to erect a two chain sheep and lamb works for export at Fraser Road, Takapau (shown on Map I) with full processing facilities except that casings and skin processing would be undertaken at the company's existing works at Whakatu. One of the chains is to be transferred from the Gear Meat Company Limited at Petone.<sup>1</sup> The company is basically a processing agent, owning only a minor portion of the throughput as by-products. It has been stated that the company has proposed the project because it felt that it was not serving its existing farmer clients within its Rebate Area<sup>2</sup> due to shortage of killing space at its Whakatu plant.

According to the feasibility report<sup>3</sup>, some twenty one (21) sites were investigated in depth before finally deciding on the site at Takapau.

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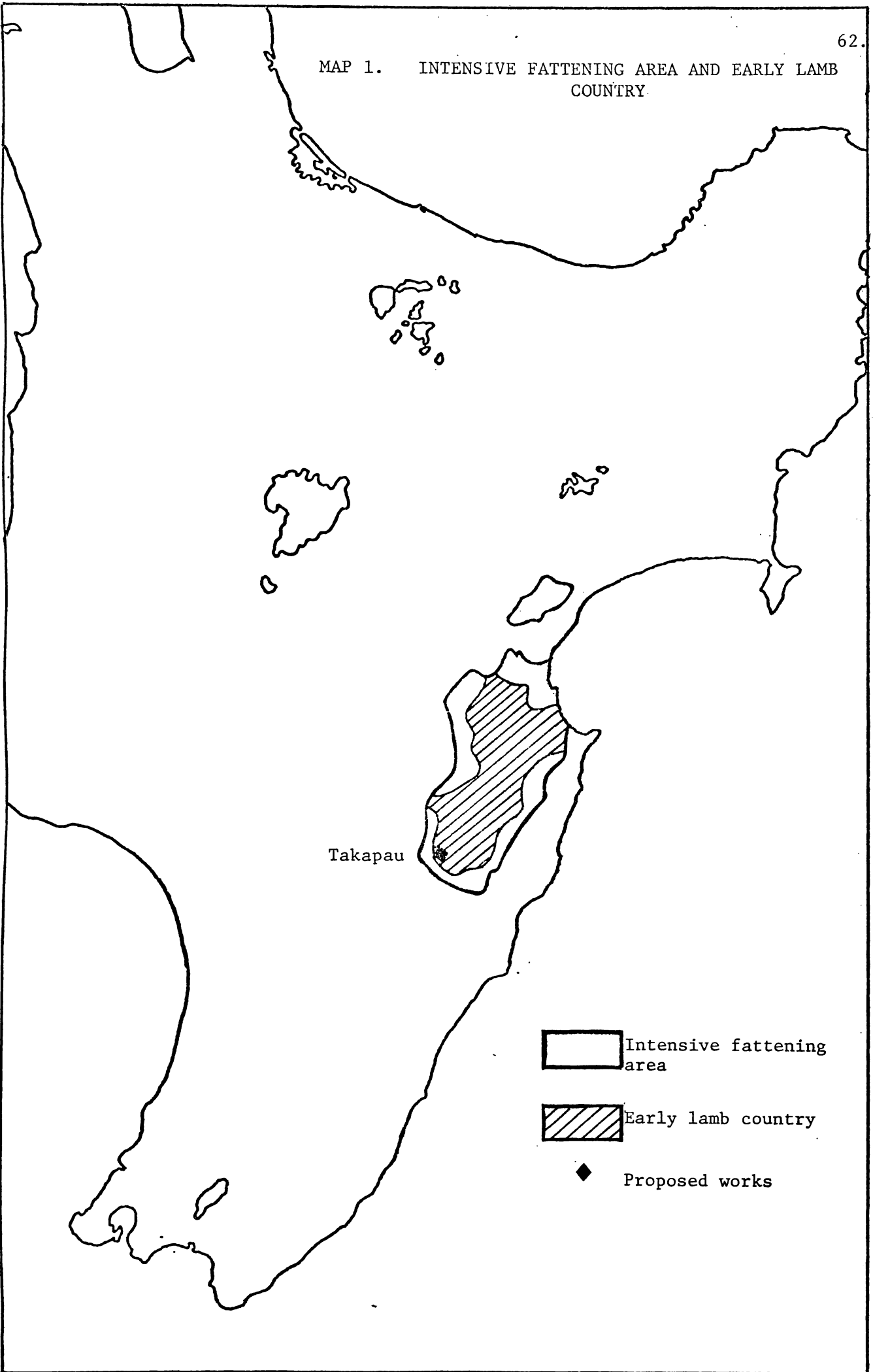
<sup>1</sup> Most of the information in this section is taken from the application made to the Authority by HBFMC, other submissions made to the Authority in support of its application and the report of the feasibility study of the project.

<sup>2</sup>The Rebate Area includes the counties of:




Rotorua	- 30%	Patangata	-100%
Taupo	- 85%	Dannevirke	-100%
Wairoa	- 30%	Woodville	-100%
Hawkes Bay	-100%	Pahiatua	- 10%
Waipawa	-100%	Akitio	- 50%
Waipukurau	-100%	Rangitikei	- 10%

<sup>3</sup>The feasibility study was carried out by PA Management Consultants Limited in 1975.

MAP 1. INTENSIVE FATTENING AREA AND EARLY LAMB COUNTRY



Takapau

-  Intensive fattening area
-  Early lamb country
-  Proposed works

The site has been appraised to a stage where it is certain that there is no technical problem that would hinder the establishment of the project. It is adjacent to the area with high sheep density and approximately 2.2 million sheep are available within a 20 mile radius<sup>4</sup>. More important, Takapau is located at the southern extremity of intensive, early fat lamb country. The area has the ability to finish store lambs from surroundings, thereby making the number of stock available for kill very high. The area is shown on Map I together with a belt of early lamb country. According to Burrige [1962, p.29], "The new lamb season in this area traditionally begins after Labour Day, this being the earliest lamb-kill in New Zealand". The coastal strip, on the other hand, tends to be much later for fat lambs extending right into May and June unless pressed by drought. Thus the season starts very early with the locality's famous early lambs, then moves onto average lambs and then the later lambs coming from the coastal area. On account of these factors, the feasibility report further states that the proposed works will have exactly the same killing pattern as that of Whakatu. This is shown in Figure 6.

The long killing season will have beneficial effect on the workforce. It is estimated that only about 30 per cent of the labour force will be employed less than six months. Moreover, it is understood that forestry developments on the Ruahine will provide seasonal work complementary to that of a meat freezing works, and thereby further reducing the problem of off-season unemployment.

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<sup>4</sup>HBPMC's submissions to the Authority - evidence of Mr W.H. Barker.

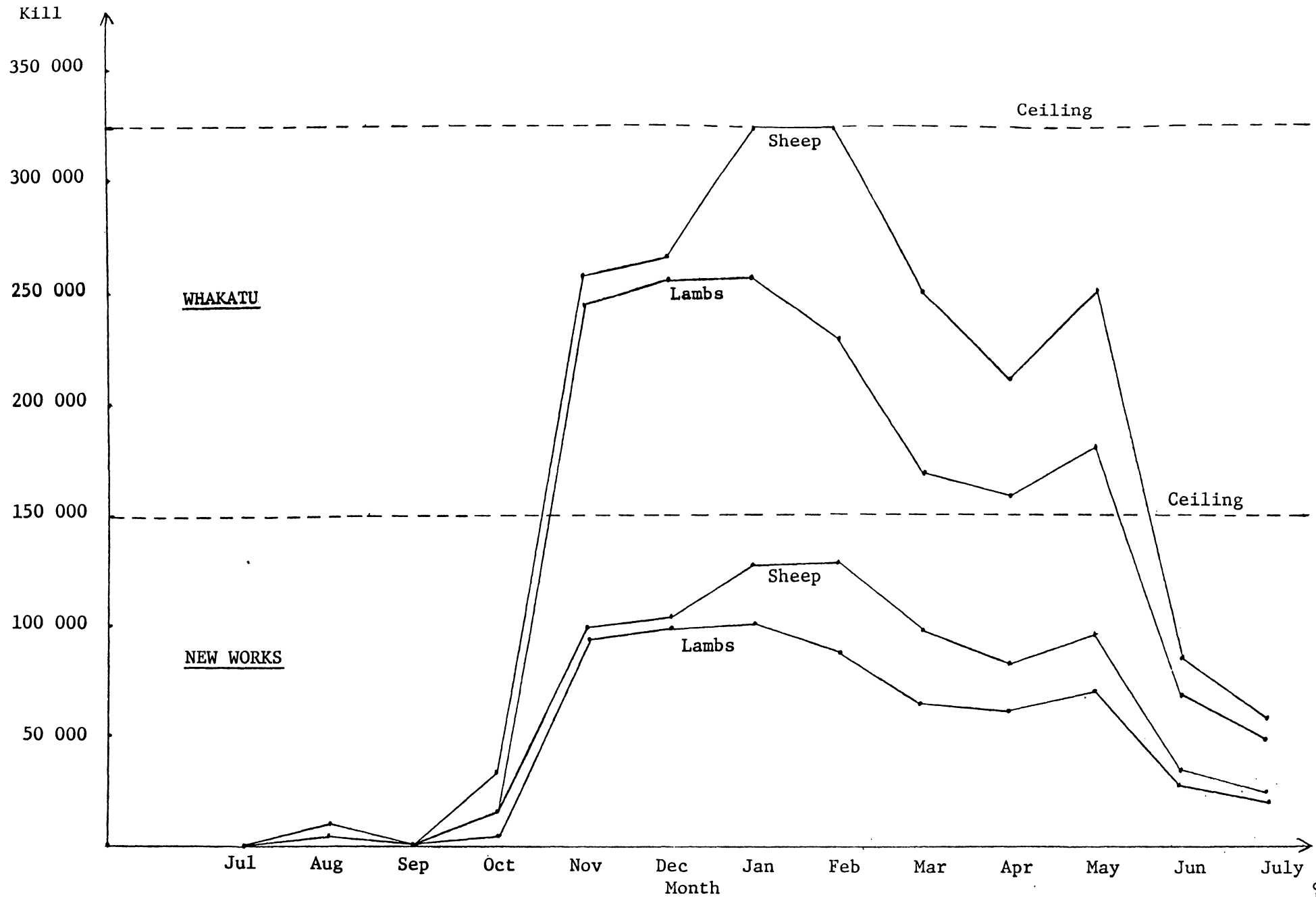


Figure 6. Kill pattern through year.

Source: Feasibility Report (1975).

### Production Process

A brief account of the production process will make it easier to understand the financial and other aspects of the project. First of all, it is essential that animals must be healthy and killed hygienically. The same facilities for processing are used for sheep and lambs; therefore, with regard to capacity requirements, the two classes of stock can be treated as homogeneous input by using an equivalence ratio<sup>5</sup>. After slaughter the sheep are pelted. The viscera and offal are then removed and part goes to the casings section, and that remaining is cartoned as "fancy meat". The skins are immediately sent to fellmongery. All waste products go to the rendering section of the plant, where they are processed into animal feed, fertilizer, and tallow (i.e. margarine, soap-making etc.)<sup>6</sup>

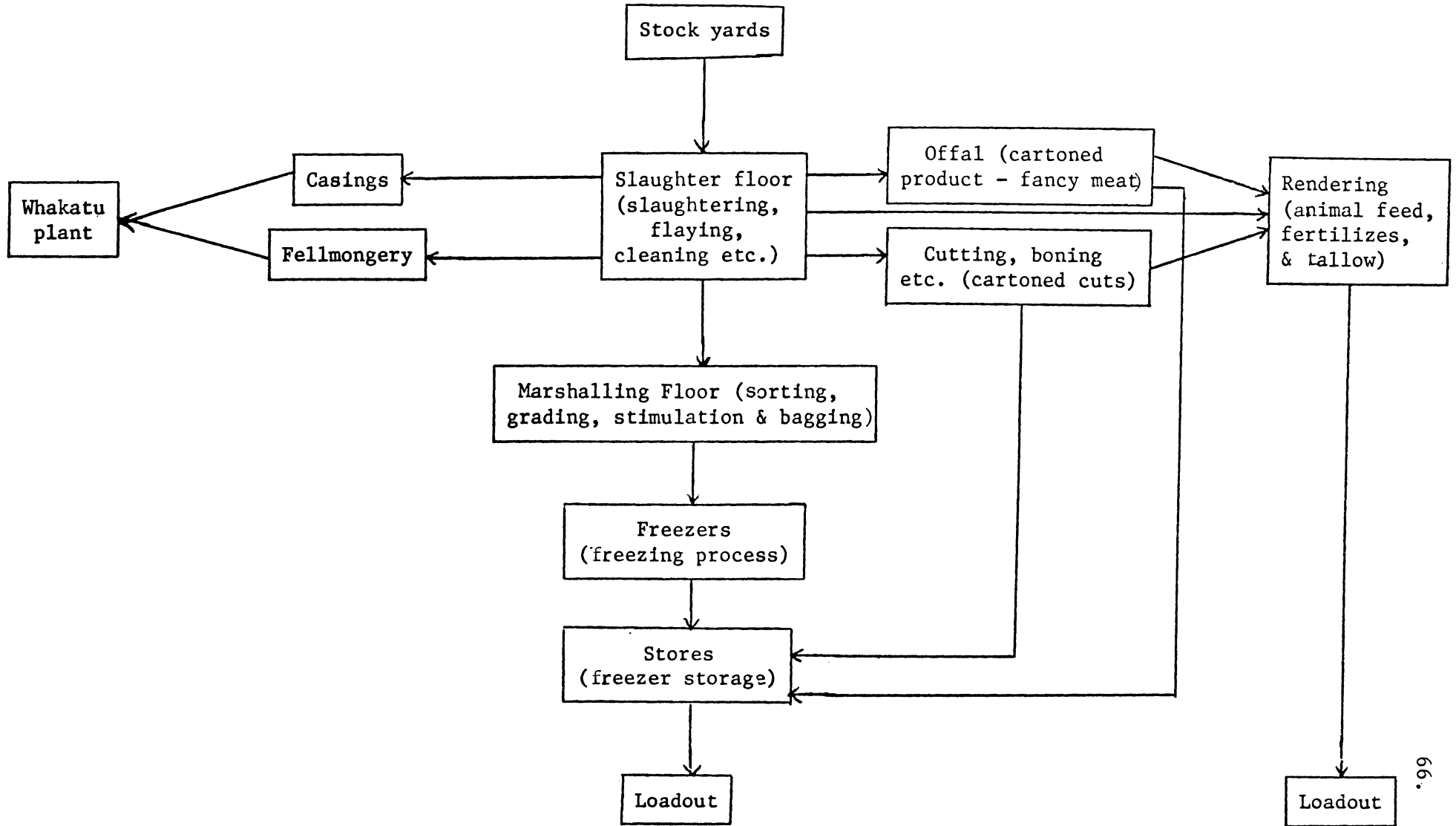
According to market requirements, some carcasses are sent for cutting. Bone, cartilage, fat, tendons, and tough parts are removed there by a large specialised labour force with hands and then are packed in cartons. The remaining carcasses are moved to the marshalling floor for sorting, grading, stimulation, and bagging. After freezing, they are kept in cold store and are ready for loadout. The process is described with the help of a schematic flowsheet on page 66.

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<sup>5</sup>An equivalence ratio is arrived at by taking into account the differences in time taken for processing sheep and lambs. Customarily, N.Z. freezing industry uses 1 sheep = 1.25 lambs.

<sup>6</sup>A detailed description of the handling and processing of the various by-products in New Zealand freezing works is given in Chisholm [1950a & 1950b].

MEAT PROCESSING FLOWSHEET



It would appear from the foregoing description of the production process that the project is both capital intensive as well as labour intensive. It will require costly slaughterhouse and extensive refrigeration equipment for freezing and storing. Some 335 persons, skilled and semi-skilled, will be employed on the project. According to the feasibility report, most of them will have to be imported into the district from other areas.

#### Summary of Financial Analysis

The proposed mutton and lamb processing works at Takapau, will be constructed, operated and administered by HBFMC, which is wholly a domestically owned company. The company has quasi-cooperative character and approximately 60 per cent of its shareholders are farmer suppliers<sup>7</sup>. The project was commenced in the year 1977-78<sup>8</sup> (to be referred to as year 0) and has an expected lifetime of 20 years. The construction and plant installation will take a period of approximately three years, starting in 1979 (i.e. year 2)<sup>9</sup>. The works is expected to begin operation in year 4 (1981-82) with a pilot kill of 450,000 sheep and lamb. This throughput represents only 60 per cent of capacity and will continue to expand until it reaches full capacity in year 6 when it is expected to have a kill of 750,000. Table 2 gives a time profile of the total kill of the works.

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<sup>7</sup>For early history of the company, refer Fallwell [1956].

<sup>8</sup>In fact, the proposal was put up much earlier but the company was planning to start the construction in 1977-78 on obtaining a licence. However, the Authority declined to issue a licence to the company in December 1977. In the expectation of obtaining a licence, the company made a start and incurred some capital expenditure during 1977-78 in the form of fees etc. It is, therefore, reasonable for a private concern to assume the commencement of the project from the year 1977-78 for costing convenience.

<sup>9</sup>The reason for such a delay in starting construction is the legal constraint. The company is still waiting for the Authority's decision on licence.

Table 2. Total Kill of Works by Year

Throughput	Year			
	0-3	4	5	6-19
Sheep and Lamb	0	450,000	650,000	750,000

Source: Compiled from the Feasibility Report, 1975

The plant will be constructed on 60 acres of land owned by the company<sup>10</sup>. It will comprise a three chain slaughterboard building, but in all other respects will be sized and equipped as a two chain operation. So far as the financial aspects are concerned, total investment requirement of the project is estimated at \$15.51 million (using current prices) of which \$2.535 millions will be in direct foreign exchange mainly for machinery and equipment<sup>11</sup>. The remaining cost represents items that are to be purchased locally. Table 3 provides a time series of the investment outlay according to various items. It should be noted that item *land* is not included in the investment outlay as the land is already owned by the company and thus involves no additional cost on its part.<sup>12</sup> However, the sum of

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<sup>10</sup>The company purchased a site of 560 acres at Fraser Road in 1975, of which 60 acres of land will be used for constructing the facilities.

<sup>11</sup>In the feasibility report, breakdown of costs into foreign exchange and domestic component is not given. These figures were obtained by personal communication with PA Management Consultants Limited.

<sup>12</sup>At the same time, it should be noted that no benefit of that ownership has been accounted for.

Table 3. Investment Costs by Year

(\$000's)

Item	Year					Total
	0	1	2	3	4	
Siteworks	-	-	250	100	100	450
Buildings	-	-	1,960	4,670	1,751	8,381
Mechanical	-	-	300	600	393	1,293
Refrigeration	-	-	50	300	1,095	1,445
Services	-	-	75	630	1,345	2,050
Pallets & Vehicles	-	-	-	150	200	350
Fees	40	60	150	300	350	900
Contingency	-	-	90	150	401	641
Total	40	60	2,875	6,900	5,635	15,510

Note 1977-78 is referred to as year 0.

Source: Compiled from the Feasibility Update Report, March 1979.

\$1 million (attributable to the new works), that is required to extend the Casings and Fellmongery facilities at Whakatu is included in the investment outlay.

The total operating costs of the project is expected to be at an annual rate of \$5.136 million when the works is operated at 100 per cent capacity, of which the share of fixed costs (overhead costs) will be \$0.344 million. According to the feasibility report the reason for this low overhead costs is that the new works will make use of certain facilities at Whakatu such as computer, costing, technical services etc. A summary of these operating costs over the lifetime of the project is given in Table 4.

Table 4. Total Operating Costs

(\$000's)

Item	Year			
	0 - 3	4	5	6 - 19
Variable or Direct Costs	0	2,875	4,153	4,792
Fixed or Overhead Costs	0	344	344	344
Total	0	3,219	4,497	5,136

Source: Compiled from the Feasibility Update Report, March 1979.

It has been assumed in the feasibility report that all fixed capital other than buildings and structures will have a perfect productive life for 15 years after its installation, but that at the end of this period (i.e. year 19), it will collapse with no residual value. It means a decision on reinvestment in plant and machinery including a decision on future capacity will have to be taken at that time. The report then goes on to assume a depreciation allotment of 2 per cent per annum flat on buildings and structures. This implies that buildings and structures in year 19 will be depreciated by  $^{15}/_{50}$ , thereby reducing their residual value to \$6.51 million at current prices.

It is further assumed that the project will be financed by raising a loan. Total borrowing over the period will be of the order of \$13.5 million and most likely will be undertaken domestically.

A summary of the net cash flow of the project is given in Table 5. It should be noted that the government imposes a 45 per cent flat rate tax on profits net of depreciation. The present value of this cash flow, discounted at 7 per cent, is +\$840,000 and discounted at 8 per cent, it is -\$105,000, which gives a discounted cash flow return or the internal rate of return of approximately 7.88 per cent (Table 6). This return on capital is low since loan required to finance the project could not be secured at any similar rate of interest. The project does not appear to be attractive from the point of view of the enterprise undertaking it. However, according to the General Manager of HBFMC, Mr I.D. Cameron, the Takapau project is not to be treated as a separate entity but as an extension of the Whakatu plant. Although a loan would have to be undertaken for the construction of the new works, the company by using a combined cash flow would be able to return the loan within 6 years from the year processing starts. This may mean a subsidy from the existing shareholders to the suppliers, but the company is more interested in providing service to its clients than giving high dividends.

The Hawkes Bay premium and the Whakatu rebate do improve the viability of the project from the industry's point of view. A sum of premium and rebate of 33 cents<sup>13</sup> per head generates an additional income of \$247,500 for the industry each year when operating at 100 per cent capacity. This improves the internal rate of return to 9.75 per cent (Appendix 2). It is therefore suggested in the feasibility report that the project should seek industry rather than shareholders' support.

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<sup>13</sup> 33c = 23c premium + 10c rebate.

Table 5. Cash Flow of Project

(\$000's)

Item	Year							
	0	1	2	3	4	5	6	7
Gross Revenue	-	-	-	-	4602	6648	7671	7671
Operating Costs	-	-	-	-	3484	4762	5401	5401
Operating Profit before depreciation, tax & interest	-	-	-	-	1118	1886	2270	2270
Depreciation	-	-	-	-	2450 <sup>#</sup>	750	700	670
Taxable Profit before Interest	-	-	-	-	-1332	1136	1570	1600
Tax at 45%	-	-	-	-	- 599*	511	707	720
Net Profit before Interest	-	-	-	-	- 733	625	863	880
Add Depreciation	-	-	-	-	2450	750	700	670
Net Cash Flow before Capital serving	-	-	-	-	1717	1375	1563	1550
Capital Expenditure	40	60	2875	6900	5635	-	-	-
Net Cash Flow	-40	-60	-2875	-6900	-3918	+1375	+1563	+1550

<sup>#</sup>High depreciation is due to the combined cash flow of Whakatu and Takapau.

\*Tax credit, Whakatu operation

Source: Compiled from the Feasibility Update Report, March 1979.

Table 6. DCF Return of Project

(\$000's)

Year		Net Cash Flow	Present Value	
			7%	8%
0	1977 - 78	- 40	- 40	- 40
1	79	- 60	- 56	- 56
2	80	-2875	-2511	-2465
3	81	-6900	-5632	-5477
4	82	-3918	-2989	-2880
5	83	+1375	+ 980	+ 936
6	84	+1563	+1041	+ 985
7	85	+1550	+ 965	+ 904
8	86	+1537	+ 895	+ 830
9	87	+1524	+ 829	+ 762
10	88	+1511	+ 768	+ 700
11	89	+1497	+ 711	+ 642
12	90	+1484	+ 659	+ 589
13	91	+1470	+ 610	+ 541
14	92	+1455	+ 564	+ 495
15	93	+1440	+ 522	+ 454
16	94	+1425	+ 483	+ 416
17	95	+1410	+ 446	+ 381
18	96	+1395	+ 413	+ 349
19	97	+7890	+2182	+1829
			+ 840	- 105

Year 19

Residual value of

Buildings &amp; Structures - \$ 6510

Ordinary Cash Flow - \$ 1380

\$ 7890
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$$\left( \frac{35}{50} \times 9300 = 6510 \right)$$

DCF return or IRR = 7.88%

Source: Feasibility Update Report, March 1979.

CHAPTER 9NATIONAL OBJECTIVES AND IDENTIFICATIONOF RELEVANT COSTS AND BENEFITSA. THE NATIONAL OBJECTIVES

As mentioned earlier, cost-benefit analysis of projects, though similar in form to financial analysis, differs widely as to the concept of costs and benefits and their valuation. Whereas the financial analysis of a project takes into account the money profit accruing to the project-operating entity, the cost-benefit analysis measures the effect of the project on the economy as a whole i.e. the project's costs and benefits are measured against the extent to which they contribute towards the nation's objectives. Generally nations may be assumed to have two basic, although not always equally valued, objectives: (a) to raise the standard of living of the people (the growth objective)<sup>14</sup>; and (b) to improve the distribution of income (the equity objective). New Zealand is no exception. It is stated in the Task Force Report [1976, pp. xi, 34] that, "there is a broadly-based consensus in New Zealand in favour of a reasonable rate of economic growth *provided* growth is intelligently directed to minimise the social and environmental costs and maximise the benefits. Similarly, the benefits need to be fairly distributed through sectors and through the community". However the two objectives are not always assigned the same priority - importance shifts according to the need and circumstances. For example, in the present case under

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<sup>14</sup>The phrases "raising standard of living" and "raising growth rate" are used as synonymous here, although strictly they are not.

consideration, the criteria as laid down in Section 28 (2) of the Meat Amendment Act 1976, clearly emphasize the efficiency aspect of the project rather than that of equity. The project under consideration therefore, will be evaluated in the light of its contribution to the maximization of net benefits.

It is worth mentioning here that in order to judge the economic worthwhileness of the project from the nation's point of view, there is no need to consider point (b) in the criteria separately. If any diversion of stock from the existing works to the new works does take place, its impact will automatically be reflected in the cost-benefit calculations of the project. It is quite possible that in spite of some diversion, the overall effect of the project is still favourable on the national economy and it is in the interest of the nation to implement the project. Further, it should be mentioned here that the freezing industry is so important to the farmers and to the nation that wastage of resources should be avoided and licences should be given only if it can be shown to be in the interest of the nation. However, adhering strictly to point (b) in isolation amounts to providing an umbrella for uneconomic units that happen to be there because of history, which is clearly not in the nation's interest.

One more point needs to be clarified. For certain countries, including New Zealand, the impact of a project on the balance of payments may be extremely important because of chronic shortage of foreign exchange. Even so it is unnecessary to treat the balance of payments position as a separate objective because the availability of foreign exchange is desired not for its own sake but for the contribution it makes towards other objectives, e.g. betterment of the standard of living. In this case therefore, the importance of foreign exchange will be incorporated in the project evaluation through its shadow price, and not by treating it as a separate objective.

## B. IDENTIFICATION OF RELEVANT COSTS AND BENEFITS

### Introduction

It is essential to understand the cycle of lamb production and the resultant freezing works' kill pattern before any effects of the project can be identified. Lamb production in New Zealand is of a very seasonal nature. This can be attributed to three factors. Firstly the pattern of livestock production in New Zealand is very closely aligned to the pattern of pasture growth. A shift in the livestock production pattern away from the pattern of pasture growth would have a cost in terms of less than optimum utilisation of pasture and an increased demand on management expertise. Secondly the natural breeding cycle of the ewe confines the potential lambing period, and finally the timing of kill is very critical as prime lamb is a highly perishable crop.

The seasonal nature of lamb production in New Zealand has its effect on the meat export industry that handles and processes mutton and lamb. The resultant freezing works' kill pattern is also of a seasonal nature - the season starting in early November<sup>1</sup>, with production reaching a peak in December and January, and gradually tailing off until it ceases in June or early July, depending on the supply of sheep and lamb. The cost of providing such facilities that are only used for a short time during the killing season is very high in terms of the throughput in that period. Moreover, a related problem arises in obtaining labour to work for such short periods. The labour that is forthcoming demands high wages because of the insecurity of employment and the monotonous nature of many of the individual tasks. It is therefore, in the interest of the freezing industry to increase the degree of utilisation of existing facilities and the labour employed in them.

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<sup>1</sup>In early lamb country e.g. Hawkes Bay, the season begins in late October.

However this increase in utilization cannot be achieved without causing undue delays to farmers for the reasons mentioned above. It is equally in the interest of the farmers to get their stock killed within a reasonable time after the optimum point, otherwise grave consequences in terms of cost can occur. Recurring delays can destroy farmers' confidence, frustrate the undertaking of any sophisticated management system, and therefore kill the incentive to increase production.

Another way of ensuring greater utilization of freezing works might be a shift in the pattern of livestock production which could result in the killing of stock before or after the freezing works peak killing period, the direction of shift depending on climatic and other factors within regions.<sup>2</sup> Herlihy [1970] made a study on these lines in Southland and concluded that, "the scope to change the stock inflow pattern into the Southland freezing works is limited" [p. 59]. Although no such study has been made in the Hawkes Bay region, experience suggests that the same results could be true for this region as well. Ansford<sup>3</sup> in his evidence before the Authority remarks, "Farming techniques have not changed in the past two decades to any great extent when attempting to improve the availability of ewes for early slaughter. Farmers in early lamb fattening country are still reluctant to shear ewes prior to drafting their early lambs and with early shipments favouring lightweight and Y grade lambs, the incidence of over-

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<sup>2</sup>This issue is discussed in detail in Agricultural Production Council [1970].

<sup>3</sup>W & R Fletcher (NZ) Limited's submissions to the Authority - evidence of Mr C.G. Ansford, NZ Livestock Manager of the Company.

fat carcasses is at its highest in the pre-Christmas period and this factor is more pertinent to Hawkes Bay than any other area in the North Island that I have been associated with during my period as a livestock buyer" [p. 2]. It can, therefore, be concluded that the pattern of livestock production as set by nature's timetables cannot be readily altered. The cost of doing so would be prohibitive. It is clear that the killing season of freezing works cannot be extended without increasing the on-farm cost.

#### The Affected Sectors

The proposed freezing works should be evaluated in the light of the above features of the economy and in essence this is an exercise in balancing the conflicting interest of the freezing industry and the farming community. The other effects of the project on the economy depend on the exact nature of the proposal. The best way to identify the affected sectors is to examine the situation on a "with and without basis". It should be noted that in very many cases, the situation without the project is not simply a continuation of the status quo because some changes are often expected to occur anyway. Thus an accurate description of the situation without the project involves difficult judgements on the part of the evaluator as it normally does not correspond simply to the situation "before" and "after". The project under consideration will obviously add to the cost of freezing works, but will benefit the farmers by avoiding potential farm costs due to delays in killing stock. The nature of the proposal suggests that the impact of the project will also be felt by the meat exporters as well as by the transport industry. Therefore the costs and benefits of the project will be assessed in the light of

its effects on:

- (a) The freezing Industry
- (b) The farmers
- (c) The meat exporters
- (d) The transport industry

In the calculation of costs and benefits, it is essential to know from where the new works will draw its kill. Will it take up the demand over and above what would have been killed at other works without undue delays, or some diversion of kill take place away from existing works to the new works? In the event of any diversion, allowance must be made for the effect that will have on the overall evaluation of the project. In the next chapter therefore an attempt is made to estimate the kill demand for new works by comparing the estimated total kill demand against the potential killing capacity available within the selected area.

CHAPTER 10ESTIMATION OF KILL AVAILABLE TO NEW WORKSIntroduction

In order to estimate the kill that would be available to the new works, it is necessary to determine existing and potential sheep numbers, kill yield (i.e. slaughter requirements), and the existing capacity within an appropriate area. The first and foremost problem is therefore the selection of an appropriate area for consideration.

The Area

In determining the area to be considered, a number of factors have to be taken into account. They include physical boundaries, the transport network, production pattern, and so on. Richardson [1969, pp. 224-30] describes three theoretical criteria for defining regions:

- (a) Homogeneity: implying some underlying uniform characteristic within the region e.g. similar production pattern, topography.
- (b) Nodality or polarisation: where emphasis is placed on the functional interdependence of some components or activities e.g. trade, transport network.
- (c) Planned or programmed: where the area is defined in terms of policy and unity of economic decision making.

In my definition of the area, all these three criteria are taken into account simultaneously. However, particular attention has been paid to the Authority's remark when giving its verdict on the applications made by HBFMC and Pacific in December 1977, "while an applicant may select an 'area' he considers appropriate to his application and present his case accordingly, any such area cannot be considered irrespective

of the facilities available within the area ----- or irrespective of facilities outside the area". Accordingly the area selected is the lower North Island embracing the regions of Taranaki, Wellington West, Wellington East, Hawkes Bay, East Coast, and South Auckland (only the counties of Taumarunui 50 per cent and Taupo 60 per cent).<sup>1</sup> The counties in each region are given in Appendix 3.

The physical boundaries of the area are shown on Map 2. The east side of the north boundary is clearly defined by mountain ranges (Huiarau & Raukumara). However it was difficult to decide the boundary for Taupo and the King Country regions. Discussions were held with various individuals and officers of the Ministry of Agriculture and Fisheries, the N.Z. Meat and Wool Boards' Economic Service, and the Federated Farmers Association (Hamilton) in order to obtain an estimate of the present and potential pattern of livestock flows. The King Country Survey by N.Z. Meat and Wool Boards' Economic Service 1970 was particularly helpful in determining this boundary.

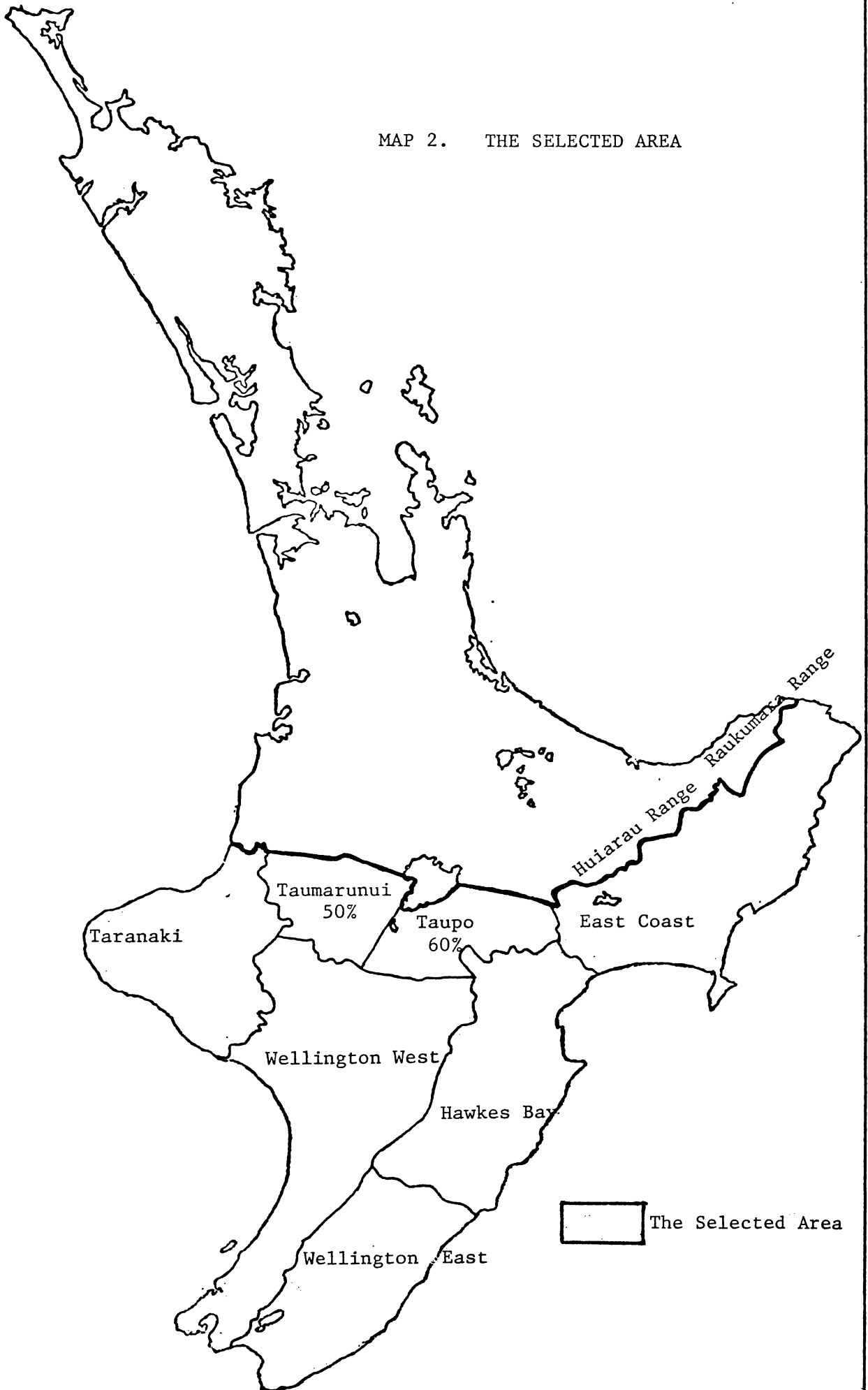
This area has been chosen in preference to other alternatives such as works' catchment areas or the area as defined in the Thomas and Gentry Report [1975] for the following reasons:

- (a) It is acknowledged that stock moves freely across the arbitrary boundary. But the nature of the boundary suggests that stock inflows are most likely balanced by stock outflows. Thus decisions taken within the area should not be influenced by the killing facilities available outside the area.

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<sup>1</sup>The percentages do not refer to the area but to the stock number e.g. 60 per cent of total sheep numbers from Taupo county will be included in the area. At present 60 per cent of the stock from Taumarunui county moves northwards. However, with Taumarunui works coming into operation from the season 1979-80 it is estimated that this percentage will be reduced to 48. For conservative estimates, 50 per cent is assumed.

MAP 2. THE SELECTED AREA



- (b) It particularly takes into account the influence of Taumarunui on the availability of killing space in Hawkes Bay - the subject of the present applications.
- (c) It takes into account the influence of all the killing facilities available within the area and thus avoids the problem of overlapping of catchment areas.
- (d) It also takes into account livestock trends both on the west and the east coasts of the lower North Island.

#### Sheep Population - Current and Future

Accurate estimation of current and future sheep population are difficult; however statistics on sheep numbers are available up to 30 June 1978. Table 7 shows the growth of sheep population and the annual percentage change since 1965 for both the Selected Area and the North Island. It is clear from this historical review that changes in sheep population are sporadic. However since 1976 there has been a steady growth in sheep numbers. The June 1978 sheep numbers of the Selected Area are approximately 0.4 per cent above the previous record level of June 1968, whereas in the North Island the corresponding figures were 3.7 per cent lower. It should be noted that the long run growth rate in the Selected Area is higher than that for the North Island and also it fluctuates less violently from year to year.

Growth patterns depend on a large number of factors (e.g. climatic, economic, social, political, and institutional) and the significance of each factor also varies from time to time. Therefore mathematical projection of any historical trend is not an appropriate method to estimate future sheep numbers as the results would depend on the selection of a particular year or the number of years chosen irrespective of the present prevailing conditions.

Table 7. Sheep Population\*

(Year ended June)

Year	Selected Area		North Island	
	Numbers (000's)	Annual % change	Numbers (000's)	Annual % change
1965	19,818	-	29,618	-
1966	20,800	+ 5.0	31,758	+ 7.2
1967	21,704	+ 4.3	33,465	+ 5.4
1968	22,033	+ 1.5	33,766	+ 0.9
1969	21,560	- 2.1	32,880	- 2.6
1970	21,724	+ 0.8	32,891	0
1971	21,203	- 2.4	31,426	- 4.5
1972	21,882	+ 3.2	32,215	+ 2.5
1973	20,629	- 5.7	29,930	- 7.1
1974	20,660	+ 0.2	29,396	- 1.8
1975	20,148	- 2.5	28,380	- 3.5
1976	20,512	+ 1.8	29,008	+ 2.2
1977	21,554	+ 5.1	30,879	+ 6.4
1978	22,114	+ 2.6	32,517	+ 5.3
Range of Annual % change		+ 5.1% - 5.7%		+ 7.2% - 7.1%
Annual Compound Growth Rate over the last 13 years		+ 0.85%		+ 0.72%

\*Detailed information by counties is set out in Appendix 4.

Source: Sheep numbers are compiled from "Sheep Returns",  
Department of Statistics.

Some subjective approach which gives due allowance to present and future expected conditions, including government policy is more realistic for planning purposes. In 1977 the Ministry of Agriculture and Fisheries produced some forecasts of the likely sheep numbers along these lines for the period 1976-82<sup>2</sup>. These forecasts take into account the following factors:

- "(a) the likely absolute and relative profitability of enterprises;
- (b) likely changes in agricultural productivity e.g. changes in breeds and lambing percentages;
- (c) likely changes in land use, e.g. afforestation, land development, cash cropping;
- (d) the likely effects of the Livestock Incentive Scheme and the income stabilisation arrangements;
- (e) the likely effects of possible changes in the location and capacity of export slaughterhouses;
- (f) any other matter peculiar to the area concerned or regarded as likely to have an important effect on livestock numbers."

[Ministry of Agriculture and Fisheries, 1977a, Appendix A, p. 13]

The MAF projection of sheep population of the Selected Area according to regions is given in Table 8. The projection gives a cumulative growth of 11.8 per cent over the period 1976-82 or an average compound growth rate of 1.9 per cent per annum. However a substantial growth in sheep numbers occurred during the first two years of the period i.e. 1977-78 (as shown in Table 7).

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<sup>2</sup>A few attempts in the past were made at estimating future livestock numbers in New Zealand for academic interest. Interested readers can refer to Pilling [1970] who uses a regression analysis for short-run forecasts. Rayner [1968], on the other hand, suggests an econometric model for estimating future sheep numbers in New Zealand; whereas Johnson [1970] employs a regional linear programming approach.

Table 8. MAF Forecasts of Sheep Numbers of Selected Area  
(1976-82)

Region	1976 (000's)	1982 (000's)	% Change 1976-82
Taranaki	1,317	1,470	11.6
Wellington West	5,172	5,644	9.1
Wellington East	3,473	4,005	15.3
Hawkes Bay	5,855	6,630	13.2
East Coast	3,532	3,795	7.4
South Auckland*	1,163	1,383	19.0
Total	20,512	22,927	11.8

\*It includes only 2 counties as defined in the Selected Area.

Source: Calculated from Appendix 4 and Ministry of Agriculture and Fisheries data.

Now it requires a total of 3.7 per cent growth over the next four years or a compound rate of 0.91 per cent per annum to reach the projected figures. On the basis of the growth that has already occurred, active government policy, incentives, and farmer confidence at present, it can be concluded that MAF forecasts are most likely to be exceeded. Nevertheless, a probable growth rate of 0.9 per cent per annum for the next four years (i.e. 1978-82) has been assumed. Further there is a limit to which cattle substitution can be carried on and the Livestock Incentive Scheme will contribute additional sheep numbers only up to June 1982.

Thereafter, it is expected that farmers will have a tendency to sustain sheep population rather than to increase it. It is therefore prudent to assume a zero growth rate for the year June 1983.

In certain quarters considerable optimism prevails especially because of the Government's commitment to a 2 per cent per annum growth in livestock numbers<sup>3</sup>. Therefore I have assumed an optimistic growth rate of 1.3 per cent. Correspondingly a pessimistic growth rate of 0.5 per cent per annum has also been assumed as others think that a substantial growth in sheep numbers has already occurred and the effect of government policy should not be allowed for in future growth rates. Table 9 and Figure 7 show the projection of sheep numbers of the Selected Area over the period 1978-83.

Table 9. Forecasts of Sheep Numbers of Selected Area  
(1978-83)

June Year	Pessimistic Growth 0.5% p.a.	Probable Growth 0.9% p.a.	Optimistic Growth 1.3% p.a.
1978	22,114	22,114	22,114
1979	22,225	22,313	22,401
1980	22,336	22,514	22,693
1981	22,447	22,716	22,988
1982	22,560	22,921	23,287
1983*	22,560	22,921	23,287

\*zero growth rate

Source: 1978 figures from Table 7.

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<sup>3</sup>Budget speech of June 1978

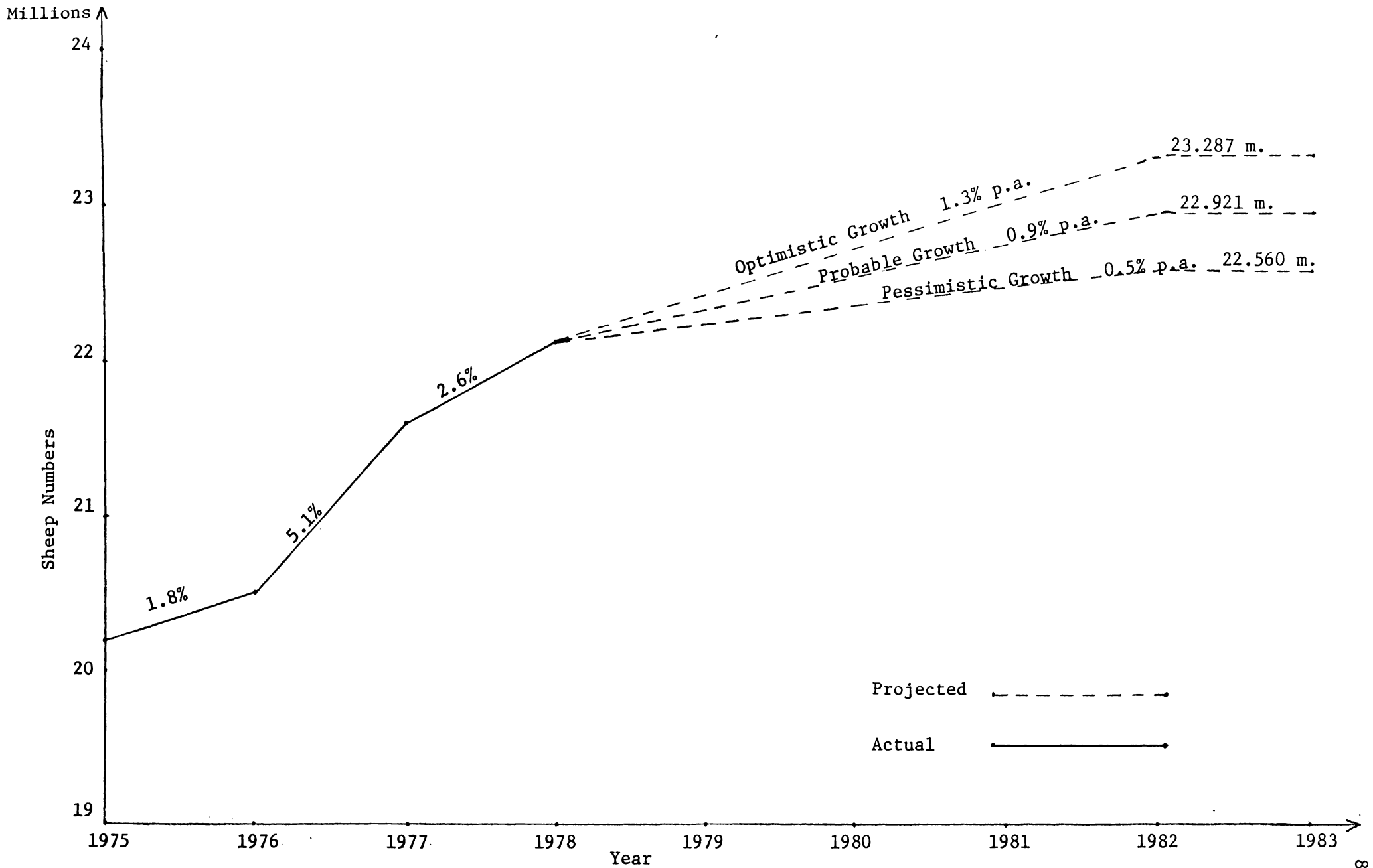


Figure 7. Projection of sheep population of Selected Area (1975-83).

### Slaughter Requirements

The usual method used for estimating the slaughter requirements is to apply a yield percentage to the sheep population. Yield is defined as the number of sheep and lambs killed during a given season (i.e. year ending 30 September), expressed as a percentage of the total sheep population at 30 June of the previous year. A number of factors influence yield, of which the following are the most important:

- (a) Ratio of breeding ewes to the total sheep population.
- (b) Lambing percentages.
- (c) Natural deaths and farm kill.
- (d) Inter-regional movements of sheep and lambs.
- (e) Increases or decreases in sheep numbers during the period.

It is difficult to assess the precise effect of each factor on the yield separately. However an overall estimate of the yield normally provides useful results.

Different estimates of yield expected from a given sheep population were presented to the Authority at the last public hearings, mainly because different regions were taken into consideration. It should be noted that all estimates more or less fall within the range as calculated by the Ministry of Agriculture and Fisheries [1977a] i.e.  $56.3 \pm 5.6$  (standard error). The region examined here for estimating yield covers the whole of the Selected Area except the counties of Taumarunui and Taupo<sup>4</sup> and it is assumed that the yield arrived at will be applicable to the whole area under study. The long term trends and in-between-year variations in the yields of sheep and lambs for the last ten years period from 1968-69 to 1977-78 are presented in Table 10 and Figure 8.

The table shows a mean lamb yield of  $42.5 \pm 2.1$  per cent and sheep yield of  $14.9 \pm 2.4$  per cent for the area under examination.

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<sup>4</sup>The counties of Taumarunui and Taupo could not be included because of paucity of information.

Table 10. Yields of Sheep and Lambs for Slaughter

(Selected Area less Taumarunui & Taupo)

Year	Total sheep numbers at 30 June (000's)	Lambs		Sheep		Total % yield
		Total kill at 30 Sept. in following year (000's)	% yield	Total kill at 30 Sept. in following year (000's)	% Yield	
1968-69	20,930	8,447	40.4	3,492	16.7	57.1
1969-70	20,442	9,271	45.4	3,528	17.3	62.7
1970-71	20,572	8,883	43.2	3,429	16.7	59.9
1971-72	20,069	9,206	45.9	3,180	15.8	61.7
1972-73	20,709	9,021	43.6	3,813	18.4	62.0
1973-74	19,498	7,612	39.0	3,103	15.9	54.9
1974-75	19,571	8,367	42.8	2,527	12.9	55.7
1975-76	19,031	8,010	42.1	2,164	11.4	53.5
1976-77	19,349	8,252	42.6	2,259	11.7	54.3
1977-78	20,342	8,122	40.0	2,512	12.3	52.3
Mean Yield			42.5		14.9	57.4
Standard Error			2.1		2.4	3.7

Source: Sheep numbers from Appendix 4; kill figures compiled from Ministry of Agriculture and Fisheries data.

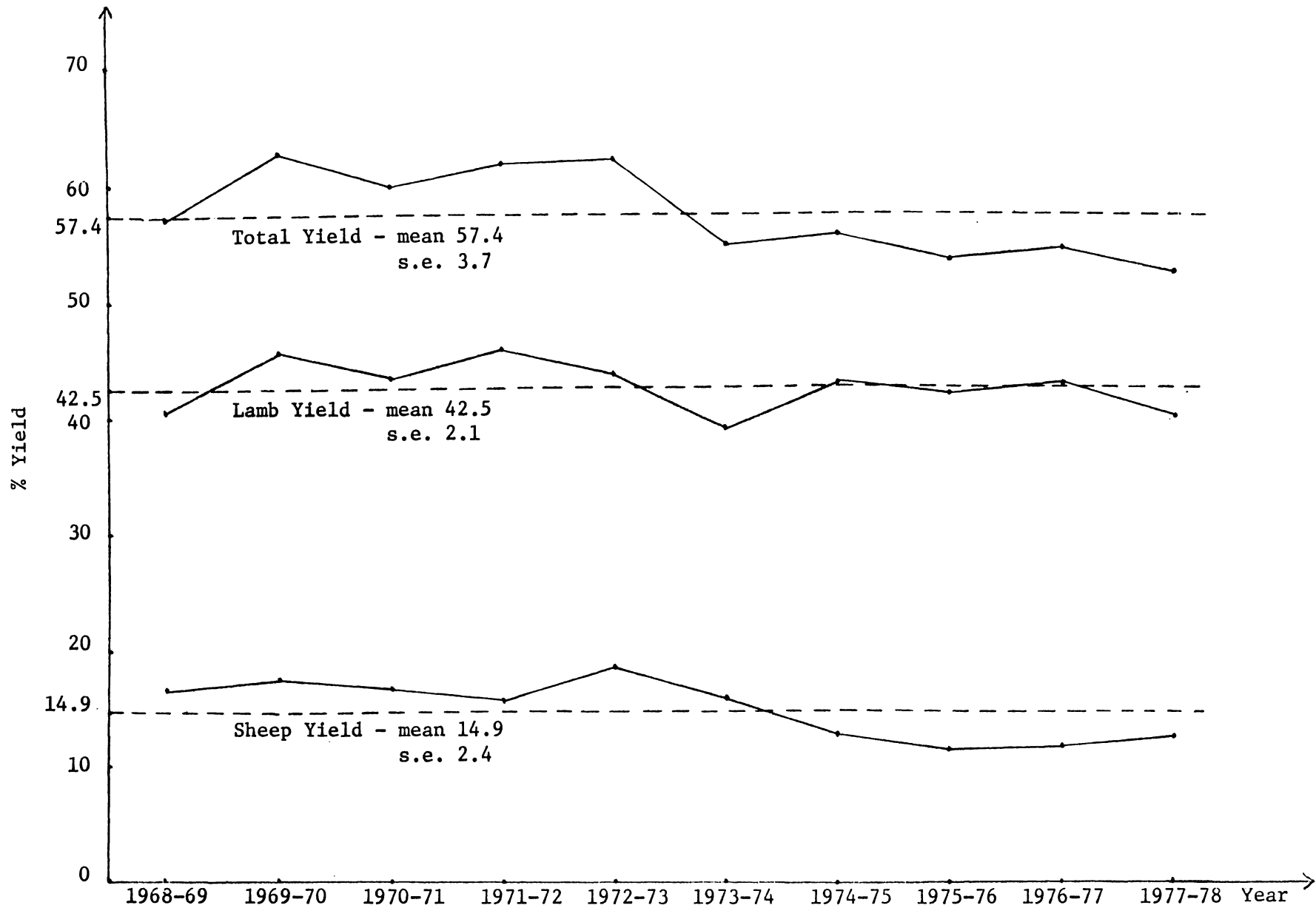


Figure 8. Yields of sheep and lambs for slaughter  
(Selected Area excluding Taumarunui and Taupo)

It is difficult to draw firm conclusions for export yield from the figures in Table 10 because of so many uncertain variables interacting upon each other. Moreover, sheep and lamb kills for the local trade are included in the yield percentages. The local trade could be of a significant order but this can be ignored as there is little evidence that kills for local consumption will increase to any substantial extent with the increase in sheep numbers. Growth in the sheep population will tend to reduce average yield as a large number of flocks are to be retained for future breeding. This influence may or may not be compensated for by other factors such as improvements in lambing percentages. Thus the export yield from a growing sheep population may remain constant or decrease to some extent.

For planning purposes it is reasonable to apply a long term trend average yield of 57.4 per cent to static sheep population but a decreasing yield will be applied to growing sheep population. Accordingly, the yields forecasted are:

Growth rate of 0.5% p.a.	-	yield 56.9%
Growth rate of 0.9% p.a.	-	yield 56.5%
Growth rate of 1.3% p.a.	-	yield 56.1%

It should be noted that a yield of 57.4 per cent is applied for the killing season 1982-83 and afterwards as zero growth rate is assumed after the year June 1982.

Forecasts of slaughter requirements in aggregate numbers (sheep + lambs) as well as in lamb equivalents up to the 1983-84 season are shown in Table 11. It is necessary to have an estimate of slaughter requirements in terms of lamb equivalents as killing capacity is often expressed in lamb units. In the conversion a sheep is taken at 1.25 lamb units - the factor used by the N.Z. meat freezing industry and N.Z. Meat Producers Board. It can be calculated from Table 10 that sheep kill makes up approximately 26 per cent of the total kill in the area under consideration.

Table 11. Forecasts of Slaughter Requirements in Selected Area

(000's)

Year/Season	Pessimistic Growth - 0.5% p.a.			Probable Growth - 0.9% p.a.			Optimistic Growth - 1.3% p.a.		
	Sheep Numbers	Yield - 56.9%		Sheep Numbers	Yield - 56.5%		Sheep Numbers	Yield - 56.1%	
		Numbers	Lamb equivalents		Numbers	Lamb equivalents		Numbers	Lamb equivalents
1978-79	22,114	12,583	13,400	22,114	12,494	13,307	22,114	12,406	13,212
1979-80	22,225	12,646	13,468	22,313	12,607	13,426	22,401	12,567	13,384
1980-81	22,336	12,709	13,535	22,514	12,720	13,547	22,693	12,731	13,559
1981-82	22,447	12,772	13,602	22,716	12,835	13,669	22,988	12,896	13,734
		Yield - 57.4%			Yield - 57.4%			Yield - 57.4%	
1982-83	22,560	12,949	13,790	22,921	13,157	14,012	23,287	13,367	14,236
1983-84	22,560	12,949	13,790	22,921	13,157	14,012	23,287	13,367	14,236

Source: 1978-79 Figures from Table 7

### Killing Capacity

In assessing the availability of kill for the new works, it is necessary to examine the existing and potential killing capacity of the existing and potential works within the Selected Area besides estimating stock and slaughter requirements. Map 3 shows the location of slaughter plants in the region under review and in the North Island. Thus 12 full freezing works slaughtering both classes of stock for export (of which one would start operating from the season 1979-80), 1 abattoir with an export licence, and 7 local trade abattoirs are situated within the boundaries of the Selected Area. The export works are:

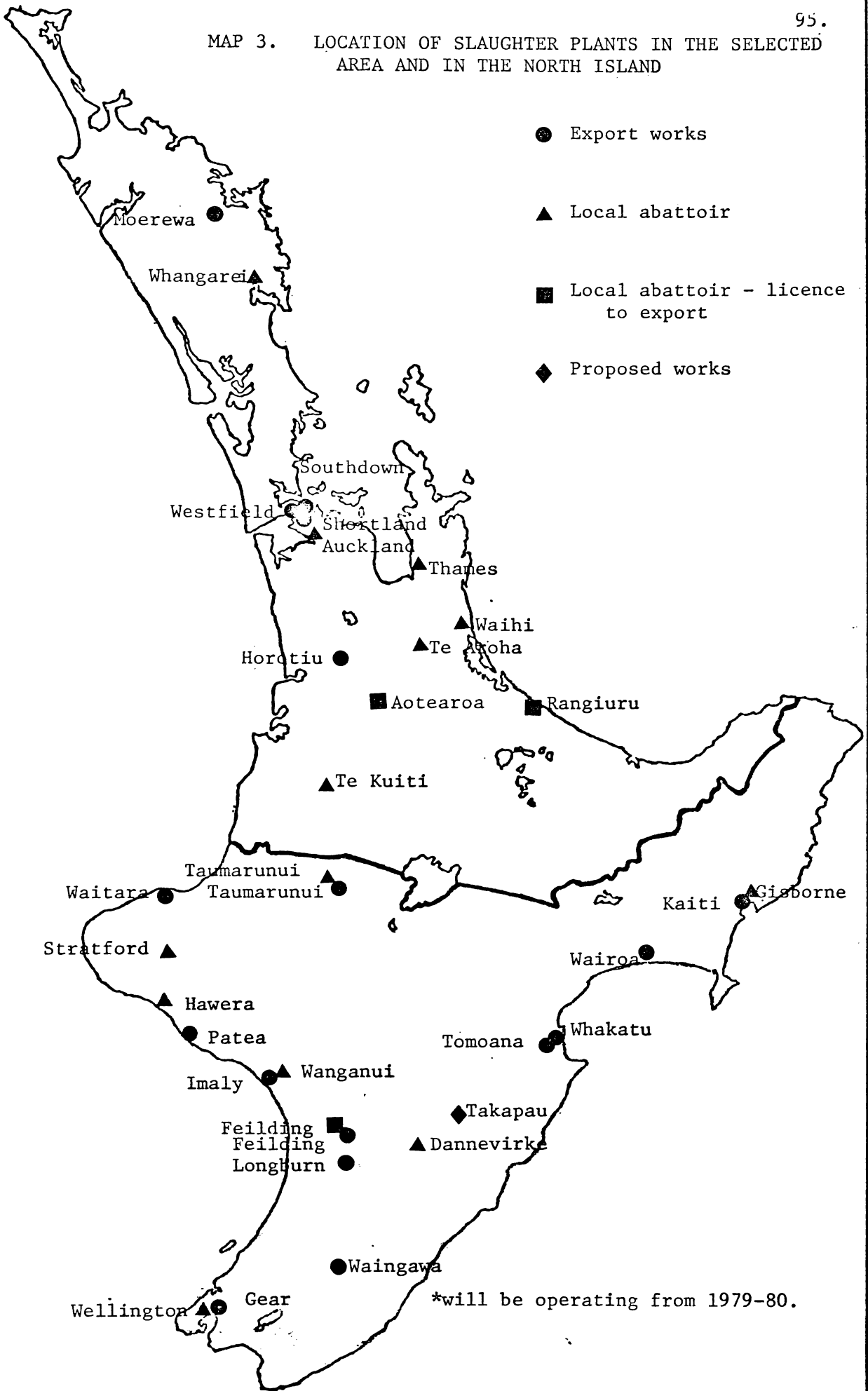
Waitara	Waingawa
Patea	Tomoana
Imlay	Whakatu
Feilding*	Wairoa
Feilding export abattoir*	Kaiti
Longburn	Taumarunui#
Gear	

\*In the analysis the kill and capacity of the Feilding export abattoir have been incorporated in the corresponding figures of the main Feilding freezing works.

#Taumarunui plant will start operating from the coming season 1979-80.

MAP 3. LOCATION OF SLAUGHTER PLANTS IN THE SELECTED AREA AND IN THE NORTH ISLAND

- Export works
- ▲ Local abattoir
- Local abattoir - licence to export
- ◆ Proposed works



\*will be operating from 1979-80.

Local trade abattoirs operated by local authorities are not considered in detail. Currently they are operating at:

Taumarunui	Dannevirke
Stratford	Gisborne <sup>5</sup>
Hawera	
Wanganui	
Wellington	

It is difficult, if not impossible to measure the total seasonal capacity of each works. The capacity of a works for the slaughter of sheep and lambs is usually based upon the throughput of each chain in terms of lamb equivalents. This throughput of the chain per day is known as the rated capacity or tallies of the chain and is determined by each works individually in collaboration with the freezing workers' union. To relate the daily capacity to total throughput the term "loading days"<sup>6</sup> is applied. As the Royal Commission states (1951, p. 28), "it is customary in the freezing industry to measure the capacity of a works for killing sheep and lambs in a season by multiplying the daily killing capacity measured in terms of lambs by 100". The rated seasonal capacity of each export works during the last two years (1976-78) is given in Table 12. The load factor for Tomoana, Whakatu and Wairoa is taken at 108 days as past results achieved suggest that Hawkes Bay has a longer killing season than other areas.

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<sup>5</sup>Gisborne abbatoir has limited export licence as well, selling to J. Wattie Canneries. But the amount is so small, that for all practical purposes it falls under the categories of local trade abattoirs

<sup>6</sup>"Loading days" is defined as the number of days it would take to handle a season's kill if a works is operated at maximum capacity i.e.

$$\text{Loading days} = \frac{\text{Season's kill}}{\text{Daily capacity}}$$

Table 12 Rated Capacities of the Works in Selected Area

Works	(During 1976-78)		(Lamb Units)
	Daily Capacity as advised before the Authority	Loading days	Rated Seasonal Capacity
Waitara	9,600	100	960,000
Patea	6,400	100	640,000
Imaly	9,300	100	930,000
Feilding	11,051	100	1,105,100
Longburn	10,050	100	1,005,000
Gear	9,600	100	960,000
Waingawa	9,147	100	914,700
Tomoana	19,200	108	2,073,600
Whakatu	18,750	108	2,025,000
Wairoa	3,200	108	345,600
Kaiti	9,600	100	960,000
Total			11,919,000

Source: Daily capacity figures are taken from W & R Fletchers (NZ) Limited's submissions to the Meat Industry Authority, November 1978.

Doubts have been expressed whether rated capacity is an accurate measure of the actual killing capacity available for the season. In effect rated capacity is an index which reflects maximum capacity that can be attained under nearly perfect conditions, i.e.

- (a) All chains are operating simultaneously.
- (b) There are no industrial disputes.
- (c) There is no shortage of labour.
- (d) There are no hygiene problems.
- (e) There is no machinery breakdown.
- (f) There are no holidays in a particular week.
- (g) There are no livestock cartage difficulties.
- (h) Maximum kill is available.

Such perfection rarely prevails in the real world and this makes the actual capacity fall short of rated.

Looking at the detailed figures in Table 13, the striking feature is that the average utilization of the available rated capacity over the last two seasons is less than 100 per cent at all works except those in Wairoa and Whakatu. Yet pressure from farmers continues with claims of undue delays in getting their stock killed. The survey report of Market Research (NZ) Limited<sup>7</sup> [1978] shows that, 61 per cent of farmers interviewed experienced delays in having lambs killed and 75 per cent experienced delays in having ewes killed during the 1977-78 season. For 1976-77 season these proportions were 30 per cent and 42 per cent respectively. Similarly, according to the Heylen Research Centre Survey<sup>8</sup> [1978], during the 1977-78 season, 67 per cent of farmers had difficulties in getting lambs killed and 83 per cent had difficulties with ewes. About 56 per cent of these farmers had such difficulties for the last three or more years. To quote Thomas and Gentry [1975, p. 8], "as farmer pressure continues in the region, one must conclude that the 'actual' killing capacity of the works has been reduced." It is clear from Table 13 that actual killing capacity of the region is less than 85.7 per cent of the rated capacity. How much less is hard to assess, as it is difficult to estimate the stock that was killed at the farmers' cost after undue delays.

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<sup>7</sup>The survey covers the region "Eastland" as defined by Pacific. It comprises the counties of Dannevirke, Woodville, Akitio, Pahiatua and Eketahuna.

<sup>8</sup>The survey covers the HBFMC "Catchment Area". It includes the counties of Hawkes Bay, Waipawa, Waipukurau, Patangata, Dannevirke, Woodville, and part of the counties of Rotorua, Taupo, Wairoa, Pahiatua, Akitio, Eketahuna and Rangitikei.

Table 13. Actual Kill and Utilization of Rated Capacity  
(1976-78)

Works	Kills - 1976-77 (L/E)	Kills - 1977-78 (L/E)	Average kills over 2 years (L/E)	Rated Capacity (L/E)	% Utilization of Rated Capacity
Waitara	734,204	928,321	831,263	960,000	87
Patea	448,410	436,387	442,399	640,000	69
Imaly	860,892	855,539	858,216	930,000	92
Feilding	811,491	624,384	717,938	1,105,100	65
Longburn	811,035	794,213	802,624	1,005,000	80
Gear	800,272	825,000	812,636	960,000	85
Waingawa	730,199	655,140	692,670	914,700	76
Tomoana	1,883,460	1,820,813	1,852,137	2,073,600	89
Whakatu	1,965,108	2,108,714	2,036,911	2,025,000	101
Wairoa	373,041	454,708	413,875	345,600	120
Kaiti	768,904	749,484	759,194	960,000	79
<b>Total</b>	<b>10,187,016</b>	<b>10,252,703</b>	<b>10,219,860*</b>	<b>11,919,000</b>	<b>85.7</b>

\*Individual components may not add to the total due to rounding.

Source: Kill figures from W & R Fletcher (NZ) Limited's submissions to the Meat Industry Authority, November 1978.  
Rated capacity figures from Table 12.

It is realistic to assume the various constraints that have caused a works to fall short of its rated capacity will continue to affect performance in the future as well but to a lesser degree because of extensive upgrading and improvements in storage and rendering capacity of certain works, increased detain rails and so on. A conservative estimate has been made that actual or most-likely killing capacity in future would be approximately 95 per cent of its rated capacity. In the exercise, both situations have been examined - the ideal situation with rated capacity and the real world situation with most-likely killing capacity.

The estimates of killing capacity (rated and most-likely) in lamb equivalents for the season 1981-82 and onwards are shown in Table 14. The daily killing capacity of Feilding export abattoir which is equal to 2000 lamb units, has been incorporated in the Feilding works' capacity. Abattoir figures are estimated from past kills. Their individual share is not significant except for Wellington abattoir which takes rather less than half of the total kill. A kill of approximately 12,253,000 lamb units seems a reasonable estimate of the most-likely capacity that would be available in the region under consideration.

#### Kill Available to New Works

To complete the exercise, the estimates of slaughter requirements and killing capacity have been put together in Table 15. The availability of kill to new works in the season 1983-84 will be the same as that of 1982-83 as zero growth rate has been assumed over this period. The table shows that the minimum kill that would be available to the new works by 1982-83 is 892,000 lamb units and the maximum is as high as 1,983,000 lamb units.

Table 14. Estimate of Killing Capacity in Selected Area

Works	Chains No	(1981-82 and onwards)			(Lamb units)
		Tallies or Rated at	Daily Capacity	Loading days	Seasons' Capacity
Taumarunui	1	1,500	1,500	100	150,000
Waitara	3	3,120	9,360	100	936,000
Patea	3	2,450	7,350	100	735,000
Imaly	3	3,100	9,300	100	930,000
Feilding	1	2,000	11,051	100	1,105,100
	3	3,017			
Longburn	3	3,190	9,570	100	957,000
Gear	2	3,200	6,400	100	640,000
Waingawa	3	3,049	9,147	100	914,700
Tomoana	6	3,200	19,200	108	2,073,600
Whakatu	6	3,320	19,920	108	2,151,360
Wairoa	1	3,200	3,200	108	345,600
Kaiti	3	3,200	9,600	100	960,000
Abattoirs*					1,000,000
Rated Killing Capacity					12,898,360
Most-likely Killing Capacity (less 5%)					12,253,442

\* Figures estimated

Source: Chain and Tallies figures from New Zealand Freezing Companies Association.

Table 15. Estimate of Kill Available to New Works

(000's Lamb Units)

Year	Ideal Situation (Rated Capacity)			Real World Situation (Most-likely Capacity)		
	Pessimistic Growth	Probable Growth	Optimistic Growth	Pessimistic Growth	Probable Growth	Optimistic Growth
1981-82						
Slaughter requirements	13,602	13,669	13,734	13,602	13,669	13,734
Killing capacity	12,898	12,898	12,898	12,253	12,253	12,253
Kill available to New Works	704	771	836	1,349	1,416	1,481
1982-83						
Slaughter requirements	13,790	14,012	14,236	13,790	14,012	14,236
Killing capacity	12,898	12,898	12,898	12,253	12,253	12,253
Kill available to New Works	892	1,114	1,338	1,537	1,759	1,983

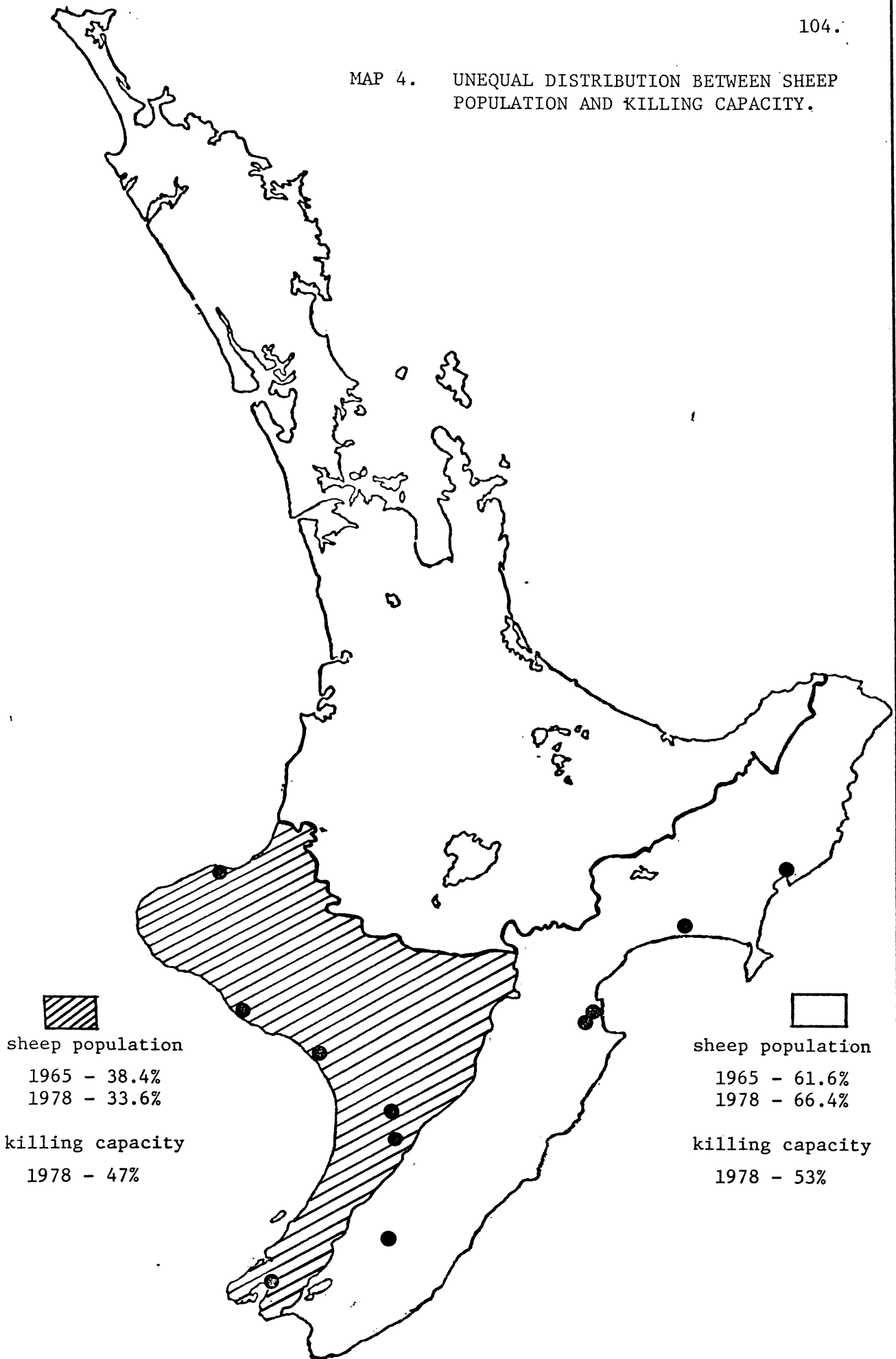
Source: Table 11 and Table 13.

However as the killing capacity of the new works is supposed to be of the order of 799,000 lamb units (i.e. 750,000 lamb and sheep), it is clear there is room for the existing works to operate beyond their rated capacity. Therefore in the subsequent exercise, it is assumed that the proposed project will take up the kill only from the increased slaughter demand over and above that which could have been killed at the existing works without undue delays i.e. if the stock is to be killed at the existing works in absence of the project, it can be killed only by extending the season thereby causing undue delays to the farmers.

It should be noted that the whole exercise has been based on an implicit assumption that the increase in kill will be presented for slaughter in the same pattern as has existed in the past. It appears to be a realistic assumption in practical terms because it is difficult to change farm production patterns due to New Zealand's dependence on seasonal growth of pasture.

It is appropriate to point out here that within the Selected Area, there has been a change in the distribution of sheep population between regions (see Map 4). Excluding the counties of Taumarunui and Taupo, whereas the East side of the Selected Area (the regions of East Coast, Hawkes Bay & Wellington East) represented 61.6 per cent of the total sheep population in 1965 this share had increased to 66.4 per cent by 1978. Moreover the East side at present has 53 per cent of the total killing capacity in the area as against 66.4 per cent of sheep numbers. This broad picture of the unequal distribution between sheep population and killing capacity within the area under study is not presented to suggest zoning but it does suggest that there may be a need to change the location of plants so as to make killing capacity available in the areas where it is most needed.

MAP 4. UNEQUAL DISTRIBUTION BETWEEN SHEEP POPULATION AND KILLING CAPACITY.



CHAPTER 11VALUATION OF COSTS AND BENEFITSA. THE PROJECT AND THE MEAT FREEZING INDUSTRYIntroduction

The new works would involve substantial costs to the meat freezing industry. It requires capital costs to provide plant facilities, fixed costs to make capacity available and variable costs to process the stock. There are no direct, immediate benefits accruing to the meat industry from the project. Benefits may come later on in the form of lower variable costs due possibly to fewer restrictive practices, improved technology, manning etc.

The estimates of these costs (i.e. capital, fixed and variable costs) have been mainly taken from the feasibility report prepared by PA Management Consultants Limited [1975 and 1979]. The original feasibility study was not made as a cost-benefit analysis but as a financial analysis because the Consultants' client was a private firm. Therefore, it is necessary to make certain adjustments to the financial calculation so as to reflect costs to the nation i.e. to include or exclude some costs which have been excluded from or included in the financial analysis. Moreover, some regrouping of resource flows is also needed in order to make it suitable for cost-benefit analysis. In this section such adjustments and regrouping of resources are discussed and carried out.

Capital Costs

It should be made clear at the outset that cost-benefit analysis does not concern itself with the financing of the project i.e. with the inflow of funds and how they are repaid. Economic costs occur when

investment is actually made and resources are utilized. The only exception is if a foreign loan is tied to the project, in which case its cost to the nation is the stream of associated repayments. In the case of the project under study, no such tied loan is associated with its financing and therefore, its capital costs are reckoned at the time the physical investment is made.

To make an economic evaluation of the costs of this project, it is necessary to distinguish between imported and domestically supplied inputs and between different types of labour. For the purpose of this case study, the resource flows are categorized in the following way:

- (1) Foreign exchange component
- (2) Domestic component -
  - (a) domestic materials
  - (b) professional/technical labour
  - (c) semi-skilled/unskilled labour

No such breakdown of resources was given in the feasibility report. However personal discussion with PA Management Consultants Limited, revealed that some \$2.535 million of overseas funds would be required to import material directly from abroad, which is approximately 16.3 per cent of total capital costs. Much of it would be spent on the purchase of freezers, machinery and other sophisticated equipment. As all types of labour are available locally, no personnel would be recruited from abroad. An itemized, year-by-year breakdown of the foreign exchange component of capital costs is shown in Table 16 where 1977-78 is referred to as year 0. The table is constructed exactly on the same lines as Table 3 and all items are included to preserve the symmetry.

Table 16. Foreign Exchange Component of Capital Costs

(\$000's)

Item	Year					Total
	0	1	2	3	4	
Siteworks	-	-	16	7	7	30
Buildings	-	-	295	700	265	1,260
Mechanical	-	-	60	120	80	260
Refrigeration	-	-	12	75	273	360
Services	-	-	15	126	269	410
Pallets & Vehicles	-	-	-	40	50	90
Fees	-	-	-	-	-	-
Contingency	-	-	18	29	78	125
<b>Total</b>	-	-	416	1,097	1,022	2,535
Import Taxes	-	-	9	32	62	103
Net foreign exchange component	-	-	407	1,065	960	2,432

Source: Table 3 and personal communication with PA Management Consultants Limited.

From the above information, it is possible to construct Table 17, which provides a time profile of the domestic component of capital costs according to various items.

Table 17. Domestic Component of Capital Costs

(\$000's)

Item	Year					Total
	0	1	2	3	4	
Siteworks	-	-	234	93	93	420
Buildings	-	-	1,665	3,970	1,486	7,121
Mechanical	-	-	240	480	313	1,033
Refrigeration	-	-	38	225	822	1,085
Services	-	-	60	504	1,076	1,640
Pallets & Vehicles	-	-	-	110	150	260
Fees	40	60	150	300	350	900
Contingency	-	-	72	121	323	516
Total	40	60	2,459	5,803	4,613	12,975

Source: Table 3 and Table 16

It is however, necessary to categorize this domestic component of capital costs into professional/technical labour, semi-skilled/unskilled labour and domestic materials. A sum of \$5.913 million would be paid out to all types of labour in the form of wages and salaries (including fees). It was difficult to estimate the share of each type of labour according to various items; however, on the whole it was estimated that approximately 30 per cent of total labour bill would go to professional/technical personnel. On this basis, Table 18 gives an account of the labour share of capital costs during the period of construction and plant installation.<sup>1</sup>

<sup>1</sup> Based on discussion with PA Management Consultants Limited.

Table 18. Labour Component of Domestic Capital Costs  
(\$000's)

Item	Year					Total
	0	1	2	3	4	
Siteworks	-	-	46	19	19	84
Buildings	-	-	666	1,588	594	2,848
Mechanical	-	-	120	240	157	517
Refrigeration	-	-	15	90	329	434
Services	-	-	30	252	538	820
Pallets & Vehicles	-	-	-	44	60	104
Fees	40	60	150	300	350	900
Contingency	-	-	29	48	129	206
Total	40	60	1,056	2,581	2,176	5,913
Professional/ Technical (30%)	40	60	310	688	676	1,774
Semi-skilled/ Unskilled	-	-	746	1,893	1,500	4,139

Source: Table 17 and personal communication with PA Management Consultants Limited.

It was further revealed that in Table 17, about 20 per cent of *siteworks*, 40 per cent of *buildings*, 50 per cent of *mechanical*, 40 per cent of *refrigeration*, 50 per cent of *services*, 40 per cent of *pallets & vehicles*, 100 per cent of *fees* and 40 per cent of *contingency* consist of wages and salaries to labour. All these figures have been incorporated in the construction of Table 18. It should be noted that although the professional/technical personnel constitute 30 per cent of total labour costs, the year-by-year breakdown does not always

correspond to 30 per cent as such labour is not utilized in fixed proportion every year.

For a given year, the domestic capital costs minus payments to all types of labour represents the domestic materials cost in that year. Such cost has been derived from Table 17 and Table 18 and the detailed breakdown is shown in Table 19. The item *fees* has been listed for the sake of completeness. The table shows that materials worth \$7.062 million will be supplied domestically for the construction and installation of plant over the three year period commencing 1979-80.

Table 19. Material Component of Domestic Capital Costs

(\$000's)

Item	Year					Total
	0	1	2	3	4	
Siteworks	-	-	188	74	74	336
Buildings	-	-	999	2,382	892	4,273
Mechanical	-	-	120	240	156	516
Refrigeration	-	-	23	135	493	651
Services	-	-	30	252	538	820
Pallets & Vehicles	-	-	-	66	90	156
Fees	-	-	-	-	-	-
Contingency	-	-	43	73	194	310
<b>Total</b>	-	-	1,403	3,222	2,437	7,062

Source: Table 17 and Table 18

In addition to the above regrouping of resource flows, some adjustments in capital cost are also needed so that it can reflect cost to the nation. As mentioned earlier, the value of land is not accounted for in the cost of project because land is already owned by the company and therefore does not involve additional cash flows on its part. However shifting of land from one use to another does involve cost to the nation in terms of its opportunity cost i.e. the output foregone in the alternative use. In principle, the value of land is measured as the discounted value of the stream of future net earnings to which it gives rise i.e. its capitalised value. The project under consideration will use 60 acres of land, which at present is earning a net income of \$4,000 per annum from grazing stock. For want of better information, it is assumed that it will continue to earn the same amount of income throughout the lifetime of the project. The land will be deprived of its present use from the year 1979-80. Its capitalised value is not determined here as it will vary with the rate of discount used. Therefore, the sum of \$4000 per annum over the life time of the project (1979-80 to 1996-97) is reckoned as the value of the land and this value is to be included in the cost-benefit analysis of the project.

Another important point concerns the treatment of tariffs and taxes. According to some economists, although these are costs to the company, they are not costs to a nation as they do not represent direct claims on the country's resources but merely reflect a transfer of control over resources and as such should be ignored in the cost-benefit analysis. However others prefer to use the opportunity cost of the inputs, which may or may not require the exclusion of taxes.<sup>2</sup> It is assumed

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<sup>2</sup>These points have already been discussed in Chapter 2.

for want of better information, that inputs of domestic materials do divert supply away from other producers and therefore taxes are to be included as an indication of the consumer willingness to pay the marginal economic value. As such, no adjustment is required in the domestic materials component. However taxes are to be ignored on all imported materials as their effect on the economy will be incorporated in the analysis through shadow pricing of foreign exchange. During the course of discussions with PA Management Consultants Limited, it was revealed that some 10 per cent of the items *mechanical refrigeration* and *services* (Table 16) would constitute import taxes. Either there is no tax on other items or it is negligible and can be ignored without affecting the results. A time series of import taxes is shown in Table 16. It should be noted that the foreign exchange component net of all taxes as shown in the last row of Table 16 is relevant for our purpose of cost-benefit analysis.

Turning to the question of contingency allowance which is usually determined by engineering and financial considerations. According to the feasibility report the amount of \$0.641 million set out as a contingency allowance in Table 3, does not cover inflation or any risk associated with the project but is a part of the expected value of the project's costs. For our purpose of cost-benefit analysis therefore contingency allowance is to remain as a part of the capital cost of the project.<sup>3</sup>

Last but not the least important is an adjustment regarding sunk costs. Sunk costs are those costs which have been incurred before the appraisal of the project and are therefore, bygones irrespective of the decision on the project. Such costs should not be included

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<sup>3</sup>This point is discussed in Squire and van der Tak [1975, pp. 20-21].

in the project's costs for the purpose of deciding whether to proceed with the project. The only costs that matter in this respect are the costs that can still be avoided. For this project, an amount of \$0.1 million that has been spent in the form of fees during 1977-78 and 1978-79 is in the nature of sunk cost. The resources to that extent have already been utilized and cannot be recovered whatever the decision of the Authority may be. Therefore the amount of \$0.1 million is to be deducted from the capital costs of the project. In effect, 1979-80 will be reckoned as year 0 for the purpose of cost-benefit analysis of the project under consideration. However all other assumptions will remain the same as stated in the feasibility report and summarised in Chapter 8.

On the basis of points discussed above, Table 20 has been compiled to give an account of the actual resources that would be used in the building and installation of the plant according to different categories on year-by-year basis. Total capital investment including

Table 20. Capital Cost Flows-Actual Resources

(\$000's)

Resource	Year				Total
	0	1	2	3-17	
Foreign exchange	407	1,065	960	0	2,432
Domestic materials*	1,407	3,226	2,441	4	7,134
Professional/Technical labour	310	688	676	0	1,674
Semi-skilled/Unskilled labour	746	1,893	1,500	0	4,139
<b>Total</b>	<b>2,870</b>	<b>6,872</b>	<b>5,577</b>	<b>4</b>	<b>15,379</b>

\*The value of land has been incorporated in the domestic materials costs..

Source: Table 16, Table 18 and Table 19.

land is expected to cost the nation a sum of \$15.379 million, of which \$2.432 million will be in direct foreign exchange. The share of labour amounts to \$5.813 million, which is approximately 38 per cent of the total capital costs.

#### Fixed or Overhead Costs

In addition to substantial capital costs, every freezing works has a component of fixed costs associated with its operation. This component of fixed costs is essential to make capacity available but does not itself vary with the volume of throughput. It follows, the project makes a net addition to the cost of the industry equivalent to the fixed costs it incurs, which would have been avoided if the extra stock had been killed at the existing works by extending the season. They should therefore, be considered as a part of the project's total costs for the purpose of cost-benefit analysis as they do make additional claims on the country's resources. According to the feasibility report the fixed costs of the project are expected to be \$0.344 million per annum starting from 1981-82 (year 2), irrespective of the volume of throughput. The breakdown of these costs according to various items are given in Table 21.

To make the fixed costs table suitable for cost-benefit analysis, it was necessary to make adjustments in the cost of certain items and resource flows just on the same lines as has been done in the case of capital costs. Since the feasibility report does not give a detailed breakdown of fixed costs according to the resources used, estimates had to be derived. From personal communication, it was disclosed that some 20 per cent of the items *insurance* and *engineers department* would involve expenditure in terms of foreign exchange and the rest would be supplied domestically.

Table 21. Itemized Annual Fixed Costs

Item	\$
Salaries	137,500
Superannuation	5,000
General Expenses	34,000
Insurances	56,000
Office Overhead	15,000
Rates	11,500
Power	6,000
Engineers Dept.	69,000
Miscellaneous Products-Losses	10,000
<b>Total</b>	<b>344,000</b>

Source: Feasibility Update Report, March 1979

The import taxes on the item *engineers department* are negligible and are therefore ignored without much error. It is further suggested that approximately 15 per cent of the item *salaries* will go to professional/technical labour. Finally it should be noted that the item *superannuation* is not in the nature of transfer payment as often thought<sup>4</sup> and as such does constitute a resource cost and is therefore included in the cost of the project.

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<sup>4</sup>New Zealand Official Yearbook 1978, p. 172.

On this understanding, Table 21 has been reconstructed as Table 22 which shows itemized annual fixed costs of the project according to different categories of the resources used. It should be noted that the foreign exchange component comprises only \$0.025 million, a little over 7 per cent of total costs, whereas labour takes up an amount of \$0.1425 million which is over 41 per cent of the total fixed costs.

Table 22. Annual Fixed Costs of Project-Resource Wise

(\$)

Item	Resource				Total
	Foreign exchange	Domestic materials	Professional/ Technical labour	Semi-skilled/ Unskilled labour	
Salaries	-	-	20,625	116,875	137,500
Superannuation	-	-	750	4,250	5,000
General Expenses	-	34,000	-	-	34,000
Insurances	11,200	44,800	-	-	56,000
Office Over-head	-	15,000	-	-	15,000
Rates	-	11,500	-	-	11,500
Power	-	6,000	-	-	6,000
Engineers Dept.	13,800	55,200	-	-	69,000
Miscellaneous Products - Losses	-	10,000	-	-	10,000
<b>Total</b>	<b>25,000</b>	<b>176,500</b>	<b>21,375</b>	<b>121,125</b>	<b>344,000</b>

Source: Table 21 and personal communication with PA Management Consultants Limited.

Variable or Direct Costs

In a freezing works variable or direct costs refer to that component of the operating costs which is directly associated with the processing of stock. Usually they relate to manpower seasonally employed, utilities such as water and electricity, and other miscellaneous services. By their very nature, such costs are not fixed but vary directly with the volume of throughput. In other words, little variation is expected in unit variable costs with different levels of throughput as most of the operations of stock processing are merely duplicated. This indication is supported by the extremely flat shape of the average variable cost curve as estimated by Cassidy, McCarthy and Toft [1970 p. 7] in the context of the beef industry. Similar results have also been concluded by Parsons and Guise [1971] in their study of the costs of operation of export abattoirs in Australia.

The level of unit variable costs may differ from one works to another depending upon the efficiency of management, technology used and so on. The feasibility report states that per head direct costs of the new works is expected to be 3.5 per cent lower than those for Whakatu, which is one of the most efficient works in the North Island, due to improved methods, manning levels etc. On the other hand, some argue that the project will have unfavourable socio-economic effects on the community by creating more off-season unemployment in the economy and this cost should be added to the project's costs. This argument is disputable and moreover difficult to quantify. Because of many uncertainties, it seems reasonable to ignore both the above favourable and unfavourable effects associated with variable costs of the project and is therefore, assumed that unit variable costs of stock processing will be the same at which ever works the stock is being killed.

On *a priori* grounds, variable costs are bound to be incurred whether stock is killed at the new works or at the existing works by extending the season. It follows that the new works does not make any additional claims on the country's resources and therefore, variable costs are not taken into account in the cost-benefit analysis of the project under study.

## B. THE PROJECT AND THE FARMERS

### Introduction

It is anticipated that the project will have favourable effects at the farm level as a new freezing works in the area will provide an opportunity for farmers to avoid delay in killing stock. This will have several benefits - stock will be killed at optimal weight and so check any deterioration in quality, and it will also avoid undue pressure on available pasture. There is no likely long run indirect cost to farmers associated with the project, although it was feared by some that the extra fixed costs, including the capital costs of the new works, would eventually be passed on to the farmers in the form of increased killing and freezing charges. As discussed earlier, if the current rate of increase in sheep population continues, even at the pessimistic rate suggested, the project would be drawing its kill from the additional kill demand created and not by reducing the length of the season of the existing works; and therefore, it is unlikely that the killing and freezing charges could be increased on account of this factor. On the contrary, if cost-plus pricing policy, as practised in the freezing industry at present, is abandoned, the project may promote greater levels of efficiency by increasing competition in both the processing and stock-purchasing fields.

In the absence of the project, farmers will have to hold stock which are ready to go to the works back on the farm for unreasonable lengths of time. The costs resulting from such delays could be substantial and

affect the farmer's returns not only within the season in which they occur but also in the future seasons. The reasons for this are as follows:

- (a) Delayed stock go backwards, losing both quality (i.e. grading) and weight.
- (b) Deaths occur during the delayed period from fly strike, facial eczema, lack of feed etc.
- (c) Additional costs are involved in drenching, crutching, and dipping the stock held.
- (d) Due to feed being utilized by the stock held, capital stock must be held tight and this affects their subsequent lambing performance and wool production.
- (e) The frequent hard grazing of pasture especially during summer can have a marked effect on subsequent production<sup>5</sup>.

In this section an attempt has been made to quantify the above farm costs due to delays in killing stock that would be avoided by the implementation of the project.

#### The Approach Adopted

In spite of its great importance, little research has been done on this aspect of the farming industry. However a number of *ad hoc* suggestions were made to the Authority during recent public hearings in connection with the application for a licence for the proposed project. Baker, in his submission<sup>6</sup>, attempted to estimate the total cost of delays during the 1977-78 season in the Wairarapa on the basis of a case study of an average Wairarapa Farm Improvement Club farm. Although these estimates

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<sup>5</sup>The effects of frequent hard grazings at different times of the year on production are discussed by Brougham [1960].

<sup>6</sup>Pacific Freezing (NZ) Limited's submissions to the Authority-evidence of Mr D.O. Baker

and the approach adopted were severely criticized by O'Connor<sup>7</sup>, for want of better information, the same farm model as proposed by Baker has been taken to calculate the cost per lamb unit delayed, on the assumption that all farmers in and around the Hawkes Bay region will be effected in the same way as this model farm. However, in the costing, the methodology suggested by O'Connor has been adopted, but most of the prices are adapted from Baker's study. Although this model approach is at best a theoretical exercise, it does make an attempt to estimate the additional costs on the farm due to slaughtering delays on the basis of the knowledge currently available with regard to feed requirements of stock and the effect of different feeding levels on stock performance.

Further, it should be noted that since the project is concerned with the future, the cost estimates calculated in the subsequent exercises are based on the expected average delays that would be experienced by farmers in the season 1981-82 on account of inadequate killing capacity, other things remaining the same.

#### The Model Farm

The average Wairarapa Farm Improvement Club sheep and beef property of 684 hectares has been used as a model farm to estimate the costs resulting from slaughter delays. Stock wintered on this model farm are 3650 ewes, 1310 ewe hoggets, 240 other sheep, 191 breeding cows, 74 rising-I year heifers, 54 rising-I year steers, 36 other cattle.

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<sup>7</sup>W & R Fletcher (NZ) Limited's submissions to the Authority - evidence of Mr D.M. O'Connor.

Average lambing percentage is assumed to be 94 per cent. In calculating costs, it has been assumed that

- (1) 30 per cent of sale lambs and all cull ewes (approximately 15 per cent of total ewes) are delayed.
- (2) Average delays for lambs is 8 weeks (range 2-14 weeks) and for cull ewes is 13 weeks (range 4-22 weeks)<sup>8</sup>.
- (3) The feed available during the late summer/early autumn period is just sufficient to maintain the capital stock which includes an allowance for hogget growth of 50 grams per day<sup>9</sup>.
- (4) All of the feed required by the delayed stock (lambs and cull ewes) is taken from the breeding ewes and hoggets<sup>10</sup>. Delayed stock, therefore, does not effect the cattle on the farm and their presence, has been ignored in the cost exercise.
- (5) There is no hard grazing of the pasture<sup>11</sup>.

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<sup>8</sup>These are the minimum expected delays estimated when the freezing industry is operating at rated capacity. Under real world conditions, the delays could be much more than these. Unfortunately, the freezing industry is very coy about revealing daily or weekly kill figures. Therefore, these conservative estimates had to be taken after consulting many individuals connected with the industry.

<sup>9</sup>Since summer and autumn pasture has lower feed value than spring pasture, more is required to maintain stock.

<sup>10</sup>This is one course of action which can be taken. There are various management policies that can be adopted such as tightening up of the less susceptible stock like other cattle & dry sheep on a limited area, hard grazing of the farm, purchase of supplementary feed etc. However, it is impossible to take an average of all actions taken and therefore, the above assumption seems reasonable.

<sup>11</sup>Since all feed required by the delayed stock is assumed to be taken from capital stock, the total feed taken from the pasture, therefore, remains constant.

### Feed Requirements

First of all, it is necessary to determine the feed requirements for both delayed stock and capital stock - the former for the period as assumed above (i.e. 8 weeks for lambs and 13 weeks for ewes) and the latter for 13 weeks pre-mating period (i.e. late summer/early autumn). This has been shown in Table 23, where it is assumed that lambs delayed are fed to hold a constant liveweight of 25 kg whereas the cull ewes are fed at a rate resulting in a loss of 50 grams liveweight per day from 50 kg liveweight. The capital stock is assumed to be fed at maintenance level except hoggets which are growing at a rate of 50 grams per day.

The table shows that cull ewes eat 70 per cent of the feed required by delayed stock even when losing liveweight of 50 grams a day. Further, it should be noted that because of the feeding of delayed stock, the breeding ewes and hoggets are fed 15 per cent less on the average for 13 weeks.

### Immediate Season's Costs

The farm costs within the season in which the delays occur can be discussed under the following headings:

(i) Lambs delayed: The lambs subject to slaughter delays may go backward deteriorating both in weight and grade. However, it is assumed that lambs are fed to hold a constant liveweight and therefore an average loss of \$1.20 per head due to fall in grade over a period of 56 days delay seems reasonable. Both Baker and O'Connor used a value of \$1 per head for similar assessment for 42 days delays.

Lambs delayed - 30% of sale lambs	= 650
Deaths during delay period - 2% of 650 (Yet to be discussed)	= 13
Cost to the farm - 637 lambs @ \$1.20/head	= \$764



(ii) Cull ewes delayed: Delayed cull ewes similarly may lose value because of either a fall in carcass weight or a fall in grade due to lower weight and fat cover. A fall of 50 grams per day in liveweight of cull ewes has been assumed, which means a loss of 4.6 kg in liveweight for 91 days delay. At 50 per cent dressing outyield, a carcass weight would be reduced by 2.3 kg.

At 40¢ per kg carcass weight, loss in  
value per head = \$0.92

It is difficult to estimate an average loss of value due to the decline in ewe grade as cull ewes are not as perishable a product as lambs and therefore changes in grade occur at a slower pace. Due to variations in cull ewe liveweight and the grade that a ewe would have been given had it been slaughtered without any delay, it is not possible to calculate an average fall in ewe value on account of slaughter delays. Baker estimated this fall in ewe value at \$3 per head and O'Connor at \$1.50 per head for a decline of 1.6 kg in carcass weight. It appears \$2 per head loss in value would be a reasonable estimate (MAF, Hamilton).

Cull ewes delayed - approximately 15% of 3650 = 550

Deaths during delay period - 4% of 550 = 22  
(Yet to be discussed)

Cost to the farm - 528 cull ewes @ \$2.00/head = \$1056

(iii) Deaths during delay period: It is natural that some deaths would occur among delayed stock during the period of holding them on the farm. This death rate in cull ewes could be very high especially when kept at tight feed. A death rate of 2 per cent in lambs for 56 days delay and 4 per cent in cull ewes for 91 days delay has been assumed<sup>12</sup>.

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<sup>12</sup>These estimates are arrived at from personal communication with various personnel of Ruakura Agricultural Research Centre.

Lambs have been valued at \$12.00 per head and cull ewes at \$7.00 per head. O'Connor<sup>13</sup> is of the opinion that since most of the deaths will be from ewes which were in extremely poor condition at culling, a value of \$4.50 per head for cull ewes should be used. However, it is suggested that the value for ewes will not be markedly reduced even under poor conditions and this year cull ewe will not realise less than \$6.50 - normal price presently being \$8.00 to \$9.00 per head (M.A.F, Hamilton).

Deaths during delay period are:

Lambs - 2% of 650 = 13

Cull ewes - 4% of 550 = 22

Cost of deaths are estimated as:

Lambs - 13 lambs @ \$12.00/head = \$156

Cull ewes - 22 ewes @ \$7.00/head = \$154

Total cost to the farm due to deaths = \$310

(iv) Drenching and dipping: It is assumed that all lambs held are drenched twice during the delay period and all cull ewes delayed are dipped once. Baker estimated a total cost of \$140 for drenching 480 lambs twice and dipping 275 ewes once. It appears a cost of \$200 would be a reasonable estimate for the exercise under consideration.

Cost to the farm - drenching and dipping = \$220

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<sup>13</sup>W & R Fletcher (NZ) Limited's submissions to the Authority - evidence of Mr D.M. O'Connor

These immediate season's costs can be summarized as follows:

Costs due to

(i) lambs delayed	=	\$ 764
(ii) cull ewes delayed	=	\$1056
(iii) deaths during delay period	=	\$ 310
(iv) drenching and dipping	=	\$ 200
Total Immediate Season's Costs	=	<u><u><u>\$2,330</u></u></u>

Long-Term Costs

These long term costs are estimated on the basis of assumptions made under points (3), (4) and (5). That means, an amount of 53,235 kg DM feed utilized by delayed stock is withdrawn from breeding ewes which were just maintaining themselves and hoggets which were growing at a rate of 50 grams per day. The effect of this reduced feeding to capital stock is to depress their subsequent performance. The resulting costs are calculated as follows:

(i) Reduced lambing percentage: The late summer/early autumn is a critical period for ewe and hogget feeding as poor feeding at this time can substantially reduce the lambing percentage. As stated by Coop [1964, p. 70], lambing percentage is affected by  $\pm 6$  per cent for each 4.5 kg difference in liveweight of ewe at tuppings, for ewes between 40 kg and 60 kg liveweight.

In calculating the reduction in liveweight of breeding ewes as a result of feed taken by delayed stock, a marginal approach as suggested by O'Connor<sup>14</sup> is adopted. It is also assumed that there is a linear relationship between change in liveweight and change in feeding levels.

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<sup>14</sup>W & R Fletchers (NZ) Limited's submissions to the Authority - evidence of Mr D.M. O'Connor.

Although both these assumptions are not strictly true in the real world conditions, they are the only means by which liveweight changes can be estimated without knowing the actual liveweight of the stock and the actual dates for which stock were delayed. The reduction in feed available to breeding ewes and hoggets in proportion to their requirements as a result of feeding of delayed stock is shown in Table 24.

Table 24. Reduction of Feed Available to Breeding Ewes and Hoggets Resulting from Feeding of Delayed Stock

Stock	91 Days Maintenance Requirements kg DM	Reduction Due to Delayed Stock kg DM
Breeding ewes	265,720	39,175
Hoggets	95,368	14,060
Total	361,088	53,235

Source: Table 23

The table shows that an amount of 39,175 kg DM is lost to breeding ewes on account of slaughter delays; this is approximately 15 per cent of their maintenance requirements. As a result of this, a loss of 5.4 kg in ewe liveweight will occur. This is shown as follows:

3650 ewes fed to maintenance for 107 days @ 0.8 kg DM/day	=	312,440	kg DM
3650 ewes fed to loss 50 g/day for 107 days @ 0.7 kg DM/day	=	273,385	
Difference in feed requirements (This is approximately equal to 39,175 kg DM of Table 24)	=	39,055	
Therefore, loss of weight due to under- feeding at 50g/day for 107 days	=	5.4 kg	

By linear method, a loss of 5.4 kg in liveweight will result in a loss of 7.2 per cent in lambing percentage. However, Jagusch<sup>15</sup> is of the opinion that this relationship is unlikely to be linear and suggests that a reduction of 7.5 per cent in lambing percentage against a loss of 5.4 kg in liveweight reflects a more realistic situation. In the calculation, therefore, a figure of 7.5 per cent reduction in lambing percentage is used.

Reduction in lambs - 7.5% of 3650	= 274
Farm deaths until sale - 10%	= 27
Cost to the farm - 247 lambs @ \$11.50/head (allowing 50¢ as direct cost on the farm until sale)	= \$2841

(ii) Reduced wool production:: Research has shown that wool growth has a strong correlation with the change in liveweight of the stock. According to Coop [1964, p. 76], fleece weight changes on average by  $\pm 7.5$  per cent for each 4.5 kg change in liveweight of the ewe at mating time. An average Romney ewe in New Zealand produces about 4.0 kg of wool per annum. [Rattray, Jagusch, Clarke & Maclean, 1978, Table 5]. Hoggets not shorn as lambs average the same as or slightly more than ewes.

As calculated earlier, the liveweight of the breeding ewe is decreased by 5.4 kg due to underfeeding. Similarly, it can be shown that a reduction of 14,060 kg DM to hoggets is sufficient to depress the liveweight of a hogget by 2.7 kg below normal management targets, as follows:

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<sup>15</sup>Personal communication.

	<u>Kg DM</u>
1310 hoggets fed to gain 50 kg/day for 54 days @ 0.8 kg DM/day	= 56,592
1310 hoggets fed to maintenance for 54 days @ 0.6 kg DM/day	= 42,444
Difference in feed requirements (This is approximately equal to 14,060 kg DM of Table 24)	= 14,148
Therefore, loss in weight gain due to maintenance feeding at 50 g/day for 54 days	= 2.7 kg

On the assumption that both ewes and hoggets would respond to the same degree, a loss of 5.4 kg in ewe liveweight would depress wool production by 9 per cent, and a loss of 2.7 kg in hogget liveweight would depress wool production by 4.5 per cent.

Loss in fleece weight per ewe	= 0.36 kg/p.a.
∴ Loss in fleece weight for 3540 ewes (allowing 3% deaths)	= 1,274 kg
Loss in fleece weight per hogget	= 0.18 kg/p.a.
∴ Loss in fleece weight for 1,290 hoggets (allowing 1.5% deaths)	= 232 kg
Total loss in fleece weight	= 1,506 kg
Cost to the farm - 1,506 kg wool @ 1.80/kg <sup>16</sup>	= <u>\$2,711</u>

(iii) Poor hoggets: It is acknowledged that the inability to grow out replacement ewe hoggets can have a marked effect on their subsequent productive performance. As stated by Baker<sup>17</sup>, a reduction of 4.5 kg in liveweight in October results in a lambing percentage depression of 10 per cent for each of the first three years in the flock due to increased barrenness of poorly grown young stock. Only 50 per cent of the loss in weight gain in the autumn can be recovered over the winter.

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<sup>16</sup> & <sup>17</sup> Pacific Freezing (NZ) Limited's submissions to the Authority - evidence of Mr D.O. Baker.

As shown above, hogget liveweight gain would be depressed by 2.7 kg in autumn as a result of feed taken by the delayed stock.

Therefore,

Weight not recovered in October	= 1.4 kg	
Reduction in lambing percentage	= 3.1%	
Loss in lambs - 3.1% of 900 replacement	= 28	
Farm deaths until sale - 10%	= 3	
Cost to the farm - 25 lambs @ \$11.50/head (allowing 50¢ as direct cost on the farm until sale)		= <u>\$288</u>

It is a reoccurring cost over the following three years.

These long term costs can be summarized as follows:

Costs due to

(i) reduced lambing percentage	= \$2,841	
(ii) reduced wool production	= \$2,711	
(iii) poorer hoggets	= \$ 288	
Total Long Term Costs	- first year	= <u>\$5,840</u>
	- second year	= \$288
	- third year	= \$288

It should be noted that although it is true that ewe hoggets one year's inability to grow out effects their first three productive cycles, most farmers with various replacement policies and selective feeding can avoid this cost to a large extent in the second and third years, whereas the flexibility to do so in the first year is limited. Therefore in the subsequent calculations, the cost due to poorer growing out of hoggets in the second and third years has been ignored.

#### Total Cost of Delays

It is clear from the foregoing exercise that one season's killing delays results in reduced returns to the model farm of \$2,330 within the same season and of \$5,840 in the following season. In other words, these are the additional costs incurred by the farm due to

a single season's delays as compared to the same farm in the same season assuming all stock being killed without delay. The current season's costs constitute about 29 per cent of the total cost which indicates that the effect of killing delays is much more severe in the long run than in the immediate season.

It should be mentioned here that all farmers in the region will not suffer the cost of delays to the same extent because of the different farming systems practised and the different management policies adopted<sup>18</sup>. For example, farms that are not highly stocked or have a low ratio of off-take may not be affected to a great extent whereas farms using a two year ewe flock system could have substantial costs on account of killing delays. However, as assumed the model farm is an average farm representing the whole region.

As shown in Chapter 10, the delays would be caused by shortage of killing capacity resulting from an increase in sheep numbers and therefore, excessive queuing problems would be faced by farmers irrespective of variations in weather. However, during severe drought the costs of these delays could become prohibitive, whereas a comparatively wet good growing season could avoid much of these costs as the reduction in stock performance due to shortage of feed would be minimal. It should be noted that the above assessment of costs are based on the assumption of minimum delays that would be expected during a normal season while freezing works operate at rated capacity.

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<sup>18</sup>Jack quoted the cost of killing delays for his farm as \$8000. See "Address by N.W. Jack [p. 18] in Massey University, Department of Agricultural Economics and Farm Management [1979].

### Benefits of Project

The benefits of the project are measured by the extent to which the new killing capacity created would be able to kill the stock when ready and thereby avoid the costs associated with delay. The exercise on the model farm shows that the delay of 650 lambs and 550 cull ewes is responsible for creating additional costs to the farm of \$2,330 in the immediate season and \$5,840 in the following season. That means an additional killing capacity of the order of 1338 lamb equivalents is required to avoid these costs. In other words, each unit killed by the new works out of delayed stock will benefit the farmer on the average by \$1.74 in the immediate season and \$4.36 in the following season.

As shown earlier in Table 15, the new works would be drawing its entire kill from the additional kill demand in excess of the existing capacity i.e. from the pool of delayed stock. Therefore, the project will benefit the sheep farmers to the extent of \$4.874 million a year when operating at full capacity. A time profile of these benefits of the project<sup>19</sup> is given in Table 25, where 1979-80 is referred to as year 0.

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<sup>19</sup>It is assumed that there would be reoccurring delays. However, in reality, farmers would have tendency to reduce carrying capacity on the farm to avoid these costs due to killing delays, in which case total costs to the nation in terms of reduced production would be much more than calculated above.

Table 25. Benefits of Project to Farmers

Item	Year					
	0-1	2	3	4	5-17	18
Throughput-Lamb units	0	479,000	692,000	799,000	799,000	0
Benefits (\$000's)	0	833	3,292	4,407	4,874	3,484

Source: Appendix 5.

For cost-benefit analysis, it is now necessary to distinguish between benefits that accrue in terms of foreign exchange and those that take the form of domestic resources. Since the production of meat and wool are meant for export, the foregoing exercise suggests that all benefits are to be measured in terms of extra foreign exchange earned as a result of stock being killed without delays except item (iv) under Immediate Season's Costs i.e. *drenching and dipping*, where benefits accrue in terms of domestic resources saved and constitute only 2.6 per cent of the total benefits. Table 26 shows a time series of these benefits according to various resources.

Table 26. Benefits of Project to Farmers Resource-Wise

Resource	Year					
	0-1	2	3	4	5-17	18
Extra foreign exchange earned	0	761	3,188	4,287	4,754	3,484
Domestic resources saved	0	72	104	120	120	0
Total	0	833	3,292	4,407	4,874	3,484

Source: Table 25

## C. THE PROJECT AND THE EXPORTERS

### Introduction

New Zealand exports of sheep meat constitute nearly 60 per cent of all sheep meat entering international trade and the name "New Zealand" is particularly associated with lamb which on the average makes up 75 per cent in volume and 80 per cent in value of its sheep meat exports [Frazer, 1976, p. 54]. However, New Zealand is far away from its markets and success as an exporter of sheep meat depends upon its ability to produce meat at a reasonable price and to have it killed and processed according to market requirements as well as to deliver it on time. In the light of recently shifting emphasis on markets of different countries and due to different marketing patterns prevalent, it is difficult to assess how far the project would contribute towards the success or failure of these factors.

The demand for lean meat appears to be a world-wide experience. According to Nordmeyer [1974, p. 34], "an increasing number of the world's population - and particularly the part of the world to which New Zealand sends meat - has a prejudice against fat". Commenting on the marketing strategies for New Zealand meat, Cushen [1977, p. 5] has also stressed the need to produce more lean lamb carcasses. It is therefore necessary that lamb which is a highly perishable product, should be killed at its optimum fat content. The new works which is meant to provide this opportunity will thus help the exporters to sell their product more easily and possibly to increase their share of the market especially in the Middle East and Mediterranean regions. In addition, according to the HBFMC, the project will be designed to meet the highest export standards and will have very sophisticated processing facilities to cope with the requirements of diversified markets including the Meat Export Development Company (NZ) Limited

(DEVCO) for North America. These benefits of the latest technology may not be available to an old works without replacing its entire plant at a substantial cost. Although difficult to measure these benefits in monetary terms, the project will assist its exporter clients in meeting the varied specifications set by different markets in a better way.

In order to exploit market opportunities to the full, it is essential for exporters to enter into market at the right time. The difference between timely arrival of farm products on world markets and late arrival can be measured in terms of millions of dollars. The question then arises in what way can early kill at the new works affect the returns to exporters i.e. does early kill coincide with the appropriate time from the market point of view or otherwise. To assess this, let us examine the various markets throughout the world to which New Zealand sends lamb and mutton.

#### Lamb Markets

Major markets for New Zealand lamb are United Kingdom, U.S.A., Canada, Greece and Japan. Recently developed markets which could become one of the real growth areas include Iran and Iraq. Total tonnage shipped and tonnage shipped to major markets over the last six years are shown in Table 27.

It is clear from the table that the U.K. market takes the major share of lamb exported, almost 70 per cent on average over the last six years. Although the U.S.A. continues to be an attractive market with minimal import restrictions, quantity imported shows a very haphazard tendency. This tendency is even more dramatic in the case of Iraq. For Greece and Iran which appear to be good markets, it is impossible to predict their timing of purchase due to political Interventions. On the other hand Japan places emphasis on price and enters the market at a time which suits it.

Table 27. Lamb Shipments - Major Markets

(Year Ended September) (Tonnes, shipped weight)

Market	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
United Kingdom	220,704	197,401	223,853	204,069	210,067	179,925
U.S. Mainland	10,600	6,129	8,184	12,293	7,328	12,477
Canada	5,231	4,525	5,579	8,648	7,105	9,114
Greece	24,673	5,086	5,877	15,127	4,399	14,894
Japan	8,152	5,703	8,214	10,499	14,305	15,279
Iran	-	3,303	3,343	19,408	27,384	27,145
Iraq	-	3,708	8,465	12,782	9,051	2,733
All Others	36,575	24,635	31,880	32,437	31,738	41,937
Total	305,935	250,490	295,395	315,263	311,377	303,504

Source: Compiled from "The New Zealand Meat Producer" - a monthly publication of NZ Meat Producers Board.

On account of these factors, it is not possible to conclude just how removing the delay in killing lamb will effect exporters' returns from these markets.

However, this early kill does give an opportunity to exporters to take advantage of high prices on the U.K. market for lamb in December and January. The policy of the Meat Producers Board on new season's sales in U.K. is designed so as to avoid unduly high prices for lamb in December and January that could cause consumers to buy alternative products and at the same time to reap the benefits of early sales in the U.K. market. The monthly wholesale prices of New Zealand PM grade lamb at London over the last four seasons are shown in Figure 9 (see also Appendix 6); and the premium on average price in December/January over February/March is given in Table 28. The table indicates that an exporter is expected to gain on average 12.3 cents per kg from early sales of lamb in the U.K. market.

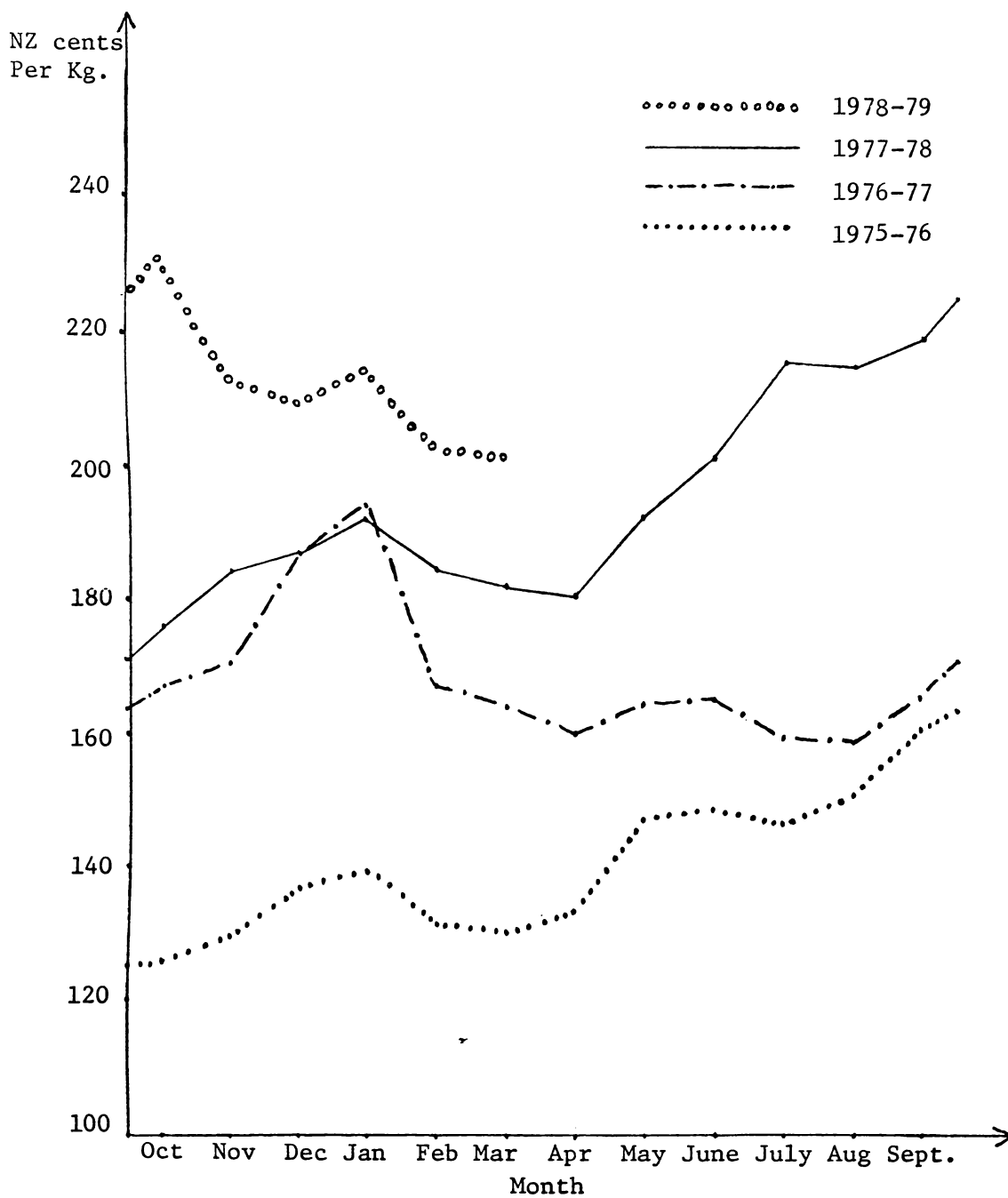


Figure 9. NZ lamb wholesale price at London (PM grade).

Source: Appendix 6

Table 28. Premium on Average Price

(PM Grade Lamb)

Season	Average Price Dec/Jan	Average Price Feb/Mar	Premium on Average Price
1975-76	137.8	130.7	7.1
1976-77	190.4	165.5	24.9
1977-78	189.8	182.9	6.9
1978-79	212.0	201.9	10.1
Average Premium			12.3

Source: Calculated from "The NZ Meat Producer" - a monthly publication of NZ Meat Producers Board.

It is worth mentioning here that the same price trends prevail for other grades of lamb i.e. PL grade and YL grade. However for convenience, the price differential on PM grade lamb only is taken into account, since it forms the bulk of the supply.

As indicated earlier, although progress has been made in developing new markets, U.K. is and will inevitably remain a major market for New Zealand lamb. In spite of the full implementation of the E.E.C's Common Customs Tariff since July 1977, under which 20 per cent duty is to be collected on all New Zealand lamb and mutton entering the U.K. market, New Zealand was able to export about 60 per cent of total lamb to the U.K. during the 1977-78 season. Although the debate on the importation of sheepmeat to E.E.C. countries remains unresolved and it will take some time before a conclusion can be reached, the present trends suggest that it is unlikely that New Zealand's share of the U.K. market would decline further. Moreover, the U.K. market is all the more important to New Zealand because it accepts

the whole range of grades and weights as opposed to severely selective markets in the Middle East, Greece etc.

In the current season, U.K. market prices during December/January were not as high as expected for the new season lamb. One of the reasons was that some 18,000/19,000 tonnes of lamb meant to fill an Iran Contract<sup>20</sup> were ultimately shipped to the U.K. in October/November. However, exporters were still able to get an extra return of 10.1 cents per kg over the sales made during February/March. This suggests that the U.K. market has remarkable capacity to absorb extra supply during December/January without depressing the price too much.

The stock killed by the end of December can reach the U.K. market on time to take advantage of higher prices. According to HBFMC, the new works is expected to kill around 150,000 lambs by this time every year when operating at full capacity, of which 80 per cent will be shipped to the U.K. market.

Total shipment to the U.K. market - 120,000 carcasses

@ 13.0 kg/carcass weight = 1,560,000 kg

Total benefits - 1,560,000 kg @ 12.3 cents/kg = \$191,880

A time profile of these benefits of early sales of lamb in the U.K. market is shown in Table 29. It should be noted that all benefits occur in terms of additional foreign exchange earned.

Table 29. Benefits of Early Sales of Lamb

Resource	(\$000's)			
	Year			
	0-1	2	3	4-17
Extra foreign exchange earned	0	115	166	192

<sup>20</sup>The meat could not be shipped to Iran because of its internal political problems.

Mutton Markets

As far as markets for mutton are concerned, the picture is somewhat simpler as New Zealand relies on a very small number of buying countries, i.e. Japan, South Korea and Russia. Recently, NZ Meat Producers Board has been paying particular attention to United Kingdom with an aim to develop it as a long-term market for mutton. Table 30 shows the tonnage shipped to these major markets over the last six years.

Table 30. Mutton Shipments - Major Markets

Market	(Year Ended September)			(Tonnes, shipped weight)		
	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
Japan	64,537	46,870	46,409	20,986	25,592	28,088
South Korea	8,741	14,860	13,171	10,919	12,651	21,411
Russia	-	20,060	30,836	27,659	44,951	6,171
United Kingdom	7,818	3,737	5,048	11,488	7,736	14,121
All others	11,151	25,290	11,740	9,001	4,031	4,877
Total	92,247	110,817	107,204	80,053	94,961	74,668

Source: Compiled from "The New Zealand Meat Producer" - a monthly publication of NZ Meat Producers Board

Russia is not a free market and its purchase orders are so erratic that it is difficult to predict the quantity and its timing of purchase. Japan and South Korea which together took 66 per cent of the total 1978 mutton exports are good potential markets but no regular monthly price quotes for these markets are available. On account of these factors, it is not possible to conclude whether 91 days earlier availability of mutton will benefit the exporters or will work against them. More research is needed in this area before any decisive conclusions can be derived.

#### D. THE PROJECT AND THE TRANSPORT INDUSTRY

##### Introduction

In this section, the long term transport implications of the proposed project from the nation's viewpoint have been assessed. It should be made clear at the start that no attempt has been made to suggest an ideal location for the new works with regard to transport costs as it is unusual for transport issues to be the only ones on which decisions are made, although transport costs could be one of the important factors in determining the location of a plant. The project would effect two facets of the transport industry, namely, the transport of livestock from farm gate to freezing works and the transport of finished products from freezing works to the port of export.

The system of collection of livestock from farm gate and its subsequent transportation to the freezing works is very complex and diverse. However for simplicity, it is assumed that all livestock travel to the works by road and there is no higher charge due to multiple pick-ups. The burden of these transport costs, at present is shared between farmers and freezing works on the basis of the port works charging system. Under this arrangement, farmers are required to pay only the cost of transportation to the local port works i.e. the nearest freezing works. If stock is rerouted to a distant works in order to provide it with economic volumes of kill, then the freezing works has to bear the extra road freight cost i.e. the difference between the cost of transport from the farm to the nearest works and the actual cost of transport. However, who pays the cost of transport is immaterial from the nations viewpoint, since we are concerned with the total utilization of resources and not who pays for them.

The development of container ports of Auckland and Wellington in the North Island has also changed the pattern of meat transportation substantially. Under the present system known as "centralisation", an exporter is expected to pay no more than the cost of transport to the traditional port and any extra cost involved in transporting the product to a more distant container port is met by the shipping lines. However, to assess the costs to the nation, "centralisation" has not been assumed and the costs calculated are actual costs from freezing works to port of export. It should be noted that pelts, wool and other non-container products are still to be exported from the nearest traditional ports but their effect on the transport industry due to the new works is negligible and is therefore ignored.

Since the project is essentially a proposal for one new chain and for one transferred chain, the effects of these two components on the transport industry are analysed separately.

#### The Effects of Transfer of One Chain

According to the proposal one chain is to be transferred from Petone to Takapau. Gear Meat Company's financial records show that it is no longer economic for the company to operate its third chain at Petone because of under utilization of the chain and high costs associated with stock acquisition. It is worth mentioning here that most of the freezing works in New Zealand today are not located with respect to the least cost situation as their locations are the result of forces which existed in the period in which the works were constructed [Burridge, 1962, p. 2]. According to Burridge, failure of works in New Zealand in the past has been partly due to disadvantages in location. Brodie and McCarthy [1974, p. 5] also reached the same conclusion when they said that "now may be the time to close down or reduce the capacity of badly located plants and establish new plants at better locations". For the last five years the Petone works on

account of its location has had to venture progressively further afield in an attempt to obtain economic volumes of kill. This has put substantial burden on its finance as the company has to pay the extra road freight cost, the vendor being charged only to the local port works. The company in its confidential submission to the Authority stated that some \$0.281 million were spent on acquiring the stock during the 1977-78 season, which did not include the Hawkes Bay rebate. The transfer of one chain will enable the Petone plant to relinquish its distant stock, of which 155,000 within the Hawkes Bay area is expected to be killed at Takapau and the remaining 136,000 is expected to improve the utilization of the west coast works. If it is assumed that all relinquished stock will be killed at its nearest freezing works, the potential saving in the cost of stock acquisition will be of \$0.218 million at current rates; this is shown in Table 31.

Table 31. Present and Potential Stock Acquisition

(Petone works - Number & Cost)

Description	Number	Cost (\$)
Total Stock Acquisition in 1977-78	891,000	281,000
Future Stock Acquisition from Petone Area*	573,000	87,000
Future Stock Acquisition from Distant Area*	27,000	9,000
Potential Savings in Stock Acquisition (at 1977-78 season rates)	291,000	185,000
Potential Savings in Stock Acquisition (at current rates i.e. March 1979) - up by 18.1% #	291,000	218,000

\*After the chain has been transferred (i.e. for two chains).

#Ministry of Transport

Source: Compiled from the Gear Meat Company's confidential submission to the Meat Industry Authority.

The crucial point is, although moving a chain from Petone shows economies in cost of stock acquisition, the relinquished stock will be killed further away from the container port of Wellington. This will naturally increase the cost of transporting carcasses to the port of export as the line haul component is higher. However it is difficult to estimate at which freezing works (except Takapau) the relinquished stock will be killed and in what quantities. Since Takapau is expected to take more than half of this kill, the transport cost from Takapau to Wellington is used as an average cost to approximate the whole region. It is also assumed that all carcasses travel to the container port by rail. The cost calculations are based on the Railway tariff as operative on March 1979. The net increase in transport cost of carcasses amounts to \$0.120 million, which is shown in Table 32.

Thus, the transfer of one chain from Petone to Takapau benefits the nation to the order of \$0.098 million per annum in terms of transport cost saved. The time profile of this cost saved is given in Table 33. As shown earlier in Map 4, there is an imbalance in the distribution of sheep population and killing capacity in the Eastern and Western parts of the Southern North Island. The proposal clearly relocates capacity close to the centre of stock in the Eastern side of the ranges and away from the Western side of the ranges where there is under utilized capacity. It is the first practical step in the rationalisation of the meat processing industry in the Southern half of the North Island as suggested by the Thomas and Gentry Report [1975] and supported by Neilson [1975].

Table 32. Net Increase in Transport Cost-Carcass Meat

Distance	Tonnage/ Container	Rate (\$)	Total Cost (\$)
Takapau to Wellington	4015 tonnage <sup>1</sup>	35.92/ton <sup>3</sup>	144,000
Petone to Wellington	446 Container <sup>2</sup>	54.29/ Container <sup>4</sup>	24,000
Net increase in cost			120,000

Source: <sup>1</sup>It is assumed that 80% of carcasses will be lamb and the rest will be sheep:

Tonnage of lambs -		
232,800 carcasses @ 13.0 kg/head	=	3026
Tonnage of sheep -		
58,200 carcasses @ 17.0 kg/head	=	989
Total tonnage	=	4015

<sup>2</sup>Number of containers -  
@ 9 tonnes/container = 446  
(Commercial Agent - New Zealand  
Railways, Hamilton)

<sup>3</sup> & <sup>4</sup> New Zealand Railways have different systems of charging for different regions. For example, Takapau to Wellington the rate is based on per ton, whereas Petone to Wellington, it is based on per container

Table 33. Benefits from Transport Cost Saved

(\$000's)

Resource	Year			
	0-1	2	3	4-17
Transport cost saved in terms of domestic resources	0	59	85	98

The Effects of One New Chain

The proposed new chain is to be established at Takapau, which is at the centre of highest density of sheep population in the North Island. As mentioned earlier, some 2.2 million sheep numbers are available within a 20 mile radius and therefore the project will draw almost all of its kill from the surrounding areas at minimum transport costs. In the absence of the project, the stock will have to be transported across the ranges westward at a substantial cost due to unequal distribution of the present available capacity. It is impossible to estimate this overall additional cost because of the ripple effect that creates uncertainty about at which works the stock would be killed, the size of collection of stock by each works, and the subsequent distance of line haulage from works to the port. It is important to note that the cost of live freight is relatively much greater than the cost of product freight. Table 34 shows the cost of transportation of one unit of livestock in comparison to the cost of transportation of one carcass for 100 km. in the Southern North Island on March 1979.

Table 34. Comparison of Transport Cost

(Livestock Vs. Carcass)

Stock Unit	Cost of Transport of Livestock via Road for 100 km. (per head) <sup>1</sup>	Cost of Transport of Carcasses via Rail for 100 km. (per carcass) <sup>2</sup>
Lambs	64.0 ¢	25.9 ¢
Sheep	90.6 ¢	33.9 ¢

Source: Calculated from

1. Ministry of Agriculture and Fisheries, "Farm costs and Prices, 1979". Technical Paper 1/79 (adjusted upwards by 3.8%).
2. New Zealand Railways tariff

It can be seen that transport costs could be reduced considerably by locating freezing works in the stock-producing areas, a factor that must be taken into account with rising oil prices when costs of road transport to the works are compared with line haul transport to the port. Experience in the United States also shows a tendency towards moving slaughterhouses in areas of livestock production [Williams & Stout, 1964].

In addition, it is more cumbersome to move livestock than meat products. If transported over long distance, livestock may lose value due to shrinkage<sup>21</sup>, death or bruising. Moreover, too much movement of stock may make it difficult to check an outbreak of disease. This was recognised by Nordmeyer [1974, p. 37] while making an inquiry into the Meat Industry as he stated "every effort should be made to minimize the risks of spreading disease by endeavouring to rationalize livestock transport".

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<sup>21</sup>Shrinkage means loss in weight during transportation.

Considering all the above factors, certainly the establishment of a new chain in the centre of source of supply will benefit the nation to a large extent. However, it is not possible to quantify these benefits with the information presently available.

CHAPTER 12EVALUATION OF THE PROJECTIntroduction

Having quantified relevant costs and benefits over the proposed economic life of the project, the next problem is how to compare them and judge the worth of the project i.e. whether the project represents an efficient use of resources. As discussed in Chapter 3, many decision rules have been suggested in the literature but the Net Present Value (NPV) criterion, based on discounted cash flow techniques, is used to evaluate the project under consideration as this method has distinct advantages over other criteria. However the NPV criterion requires the selection of an appropriate rate of discount to bring future costs and benefits to their present worth and for this purpose, a rate of 10 per cent as suggested by Treasury<sup>1</sup> has been used.

The evaluation of the net benefits of the project is carried out in three stages of approximation. Firstly it is assessed at market prices on the assumption that these prices adequately reflect the social opportunity costs and benefits of the inputs and outputs. The second stage involves the adjustment of market prices which do not reflect real opportunity costs and benefits to the nation. Finally the sensitivity of the project with respect to important variables is discussed. These three stages of evaluation form the subject matter of this chapter.

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<sup>1</sup>Discussed under shadow prices. Note this is a real rate; all values are expressed at constant prices.

### Resource Flows due to the Project

To simplify the calculations, it is necessary to consolidate the information from various tables according to different categories of resources. This is done in Table 35, which provides a comprehensive summary of all the resource flows brought about by the proposed works. Item (1) consists of capital costs (i.e. costs of construction and plant installation) in terms of the resources used and has been obtained from Table 20. Item (2), which gives the annual fixed costs resource-wise, has been compiled from Table 22. Item (3) represents benefits to the farmers in terms of foreign exchange earned and domestic resources saved and has been incorporated from Table 26. Item (4) which gives benefits to the exporters in foreign exchange, has been taken from Table 29, while item (5) showing benefits to the transport industry in domestic resources has been obtained from Table 33. Finally, item (6) consists of the terminal value (i.e. the scrap value) of the project. As mentioned earlier, the feasibility report states that the terminal value of buildings and structures is expected to be \$6.51 million (Table 6) and it is assumed that it will be wholly in terms of domestic materials<sup>2</sup>. Let us now proceed to assess the net benefits to the nation as a result of establishing a new freezing works.

### Evaluation of the Project at Market Prices

The analysis here assumes that market prices do reflect the real contribution of the resources towards national economy i.e. their opportunity costs to the nation. On this basis, it can be seen from Table 35 that items (1) and (2) consist of payments to resources that could have been used elsewhere in the economy in the absence of the project.

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<sup>2</sup>This seems reasonable as only buildings and structures will remain as scrap and much of the cost in constructing buildings and structures involved the use of domestic materials.

Table 35. Resource Flows for the Project

(\$000's)

Item	Year						
	0	1	2	3	4	5-17	18
(1) Capital costs	2,870	6,872	5,577	4	4	4	
(a <sub>1</sub> ) Foreign exchange	407	1,065	960				
(b <sub>1</sub> ) Domestic materials	1,407	3,226	2,441	4	4	4	
(c <sub>1</sub> ) Professional/Technical labour	310	688	676				
(d <sub>1</sub> ) Semi-skilled/Unskilled labour	746	1,893	1,500				
(2) Fixed costs			344	344	344	344	
(a <sub>2</sub> ) Foreign exchange			25	25	25	25	
(b <sub>2</sub> ) Domestic materials			177	177	177	177	
(c <sub>2</sub> ) Professional/Technical labour			21	21	21	21	
(d <sub>2</sub> ) Semi-skilled/Unskilled labour			121	121	121	121	
(3) Benefits to farmers			833	3,292	4,407	4,874	3,484
(a <sub>3</sub> ) Foreign exchange			761	3,188	4,287	4,754	3,484
(b <sub>3</sub> ) Domestic resources			72	104	120	120	
(4) Benefits to exporters (Foreign exchange)			115	166	192	192	
(5) Benefits to transport industry (Domestic resources)			59	85	98	98	
(6) Terminal value (Domestic resources)							6,510

Source: Table 6, Table 20, Table 22, Table 26, Table 29 and Table 33.

These items clearly measure the costs that the nation sustains because of the project. Similarly items (3), (4), (5) and (6) correspond to benefits due to the project. They represent real gains to the nation as a whole and would not have come about in the absence of the project. The net benefits at market prices in any given year of the project can, therefore, be calculated from Table 35 as

$$NB_m = - (1) - (2) + (3) + (4) + (5) + (6) - - - - (a)$$

where  $NB_m$  represents the net benefits at market prices.

To have eventually a single index of the worth of the project, it is necessary to express costs and benefits in terms of a common measure. This is done by discounting the value for each year at a discount rate of 10 per cent to calculate the present value. It should be noted, a somewhat unconventional approach is used in the analysis, which involves discounting to the present each item or group of items rather than discounting the net annual benefits flow as a whole. Since each item is discounted to the present, the number of discounting operations without a computer can create inordinate problems in calculating and can become unmanageable; however in practice, this disaggregated present value approach has many advantages.

Firstly, if the relationship between market and shadow price is constant over time or an average relationship over time can be estimated, there is no need to assign a shadow price to individual annual costs and benefits, applying a shadow price to its single present value will suffice (a mathematical proof is given in Appendix 7). Moreover, since annual values are not involved, it eliminates the need to repeat the discounting process every time a shadow price is changed. Secondly, the sensitivity analysis becomes an easy process, simply adjusting present value up or down as required. Finally, the analyst can quickly see from the present values which costs and benefits are important as it is useless to seek perfection in a shadow price or to carry out sensitivity analysis with respect to a variable which has

Table 36. Present Values in Year 0 of Items in Table 35

(\$000's)

Item	Rate of Discount		
	10%	20%	30%
(1) Capital costs	13,752	12,482	11,464
(a <sub>1</sub> ) Foreign exchange	2,169	1,961	1,794
(b <sub>1</sub> ) Domestic materials	6,382	5,803	5,341
(c <sub>1</sub> ) Professional/ Technical labour	1,494	1,353	1,239
(d <sub>1</sub> ) Semi-skilled/ Unskilled labour	3,707	3,365	3,090
(2) Fixed costs	2,447	1,357	869
(a <sub>2</sub> ) Foreign exchange	178	99	63
(b <sub>2</sub> ) Domestic materials	1,259	698	447
(c <sub>2</sub> ) Professional/ Technical labour	149	83	53
(d <sub>2</sub> ) Semi-skilled/ Unskilled labour	861	477	306
(3) Benefits to farmers	30,446	15,393	9,066
(a <sub>3</sub> ) Foreign exchange	29,644	14,963	8,799
(b <sub>3</sub> ) Domestic resources	802	430	267
(4) Benefits to exports (Foreign exchange)	1,282	688	428
(5) Benefits to transport industry (Domestic resources)	655	352	219
(6) Terminal value (Domestic resources)	1,171	245	58

no significant effect on the final result of the project.

Table 36 gives the present values in year 0 of each of the items of Table 35, discounted at the social rate of discount of 10 per cent. Substituting these values in equation (a), the present value of net benefits at market prices turns out to be positive at a level of \$17.356 million. The project seems to be highly beneficial to the nation. To test the sensitivity of the project to a change in discount rates, costs and benefits are also discounted at 20 per cent and 30 per cent (Table 36) which give the present value of  $NB_m$  as +\$2.840 million and -\$2.563 million respectively.

#### Shadow Prices

The second stage of evaluation requires certain adjustments to be made in the market prices of specific resources wherever these prices do not reflect their social opportunity cost. Such discrepancies in prices, as noted in Chapter 2, can occur for a variety of reasons and in a variety of ways. The problem therefore is to obtain shadow prices for certain goods or services or for the social rate of time preference that are appropriate for project evaluation from society's point of view. However, these shadow prices depend on the value judgements of the society as well as on the technological possibilities of the economy and on resource and policy constraints, and as such they are determined by the government or the central planning authority. In addition to the rate of discount, for the evaluation of project under consideration, two resources namely, foreign exchange and semi-skilled/unskilled labour, are singled out for shadow pricing. All the remaining resources of the project are assumed to be correctly priced.

(i) Rate of discount: The rate of discount to be used for evaluation of the projects in the public sector or that which require government approval remains a matter of controversy.

Its selection has a critical effect upon the result of the analysis and may make the difference between acceptance and rejection of a project. In order to have consistency and to provide a uniform base from which decisions can be made, it is essential that a single rate that reflects society's time preference should be used. In view of this, Treasury through its Circular 1971/13, issued instructions that all cost-benefit analysis of projects should use a discount rate of 10 per cent in their evaluation irrespective of the source of funds. It is further suggested that other rates (9 per cent and 11 per cent) should also be used to test the sensitivity of the project to a change in discount rates. It should be noted that for the project under consideration a discount rate of 10 per cent has been used and the sensitivity of the project is tested at 20 per cent and 30 per cent discount rates.

(ii) Foreign exchange: As mentioned earlier, the heavy pressure on its balance of payments has been of great concern to New Zealand for some time. This has led the government to adopt a wide range of economic measures including export subsidies and quantitative import controls, to promote export earnings and to avoid excessive drawing on overseas funds through imports. However, the need to adopt these policies is a symptom of an overvaluation of domestic currency in relation to the foreign currencies; in other words, the opportunity cost of foreign exchange is higher than its official exchange rate. It is, therefore, necessary that an appropriate shadow price of foreign exchange reflecting its true worth to the economy should be used for project evaluation. This was recognised by the government as long ago as 1971, when Treasury [Circular 1971/13] instructed that project evaluation carried out through cost-benefit analysis should apply a 10 per cent weighting to the overseas content

of its costs and benefits. In the light of the deteriorating balance of payments position, it is suggested in certain quarters that if a 10 per cent weighting was appropriate in 1971, then a much higher weighting should be used in 1979.

In response to Treasury instructions, the Economics Division of the Ministry of Agriculture and Fisheries [1977b] prepared its own overseas exchange content weighting procedure applicable to agricultural projects, where different items are assigned different weights. However in the present analysis, a uniform weight of 10 per cent to the foreign exchange component of costs and benefits of the project will be used.

(iii) Semi-skilled/unskilled labour: Finally, the problem of determining a shadow price for semi-skilled/unskilled labour<sup>3</sup> has to be considered. According to Treasury, no special price is being used for any type of labour in the evaluation of projects through cost-benefit analysis. This could be because New Zealand started facing the problem of unemployment recently, and especially from the middle of 1977. However in the face of rapidly rising unemployment in the economy, the market wage is not an appropriate price to use for social evaluation of the project, because it does not reflect the opportunity cost of unemployed labour and in addition, the creation of new jobs leads to income redistribution. In the absence of any clear-cut government policy on this matter and due to the non-availability of detailed information, a very crude approximation to the shadow wage of semi-skilled/unskilled labour is attempted here.<sup>4</sup>

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<sup>3</sup>Many jobs require skills that can be learned in a matter of weeks or months on the job itself. Such semi-skilled labour and unskilled labour are treated at par for the purpose of assessing their shadow wage.

<sup>4</sup>It is assumed that there is negligible unemployment among professional/technical labour and the market wage reflects its opportunity cost reasonably accurately and therefore no correction is required for this category of labour.

Since the analysis is not concerned with the equity aspect of the project, the effect of income redistribution on the economy from additional employment has been ignored. The shadow wage will therefore be estimated only in terms of net output foregone as a result of employing labour on the project under consideration rather than leaving it in its previous occupation. In this sense, the shadow wage is given by the market wage weighted by some degree of unemployment on the assumption that there is no wage differential between different sectors of the economy<sup>5</sup> i.e.

$$\text{SWR} = (1 - P_0) W_1$$

where  $P_0$  is the probability of drawing unemployed labour, and  $W_1$  is the market wage rate. The opportunity cost of unemployed labour is assumed to be zero. It is further assumed that the relationship between the probability of drawing labour from the idle pool and the rate of unemployment is linear.

The rate of unemployment in New Zealand rose rapidly from June 1977, although the problem had been there since 1975. In January 1979, it had risen to 3.9 per cent (about 1.9 per cent excluding those on special work and under job creation programmes). However it is suggested that these figures underestimate the real extent of unemployment in the economy as all unemployed labour do not register even if eligible and many, such as married women, are not eligible for registration. OECD Economic Surveys [1979, pp. 12-14] attributes this low level of unemployment to the changes in the pattern of migration as a result of sluggish domestic economic activity and

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<sup>5</sup>In the context of New Zealand economy, this assumption seems reasonable.

suggests that otherwise by March 1978, the rate of unemployment would have been about 6.25 per cent compared with an actual rate of 2.5 per cent. Somewhat similar results were concluded by the Reserve Bank of New Zealand<sup>6</sup>.

Amid varied estimates and judgements, it seems reasonable to assume a rate of 4 per cent unemployment and present trends in the economy suggest that this rate will most likely prevail in the near future. On the basis of this assumption, a shadow wage rate is estimated as

$$\begin{aligned} \text{SWR} &= (1 - 0.04) W_1 \\ &= 0.96 W_1 \end{aligned}$$

i.e. the real opportunity cost of semi-skilled/unskilled labour is 0.96 times that of the market wage. A negative weight of 4 per cent should therefore be applied to the semi-skilled/unskilled labour component of costs and this weight will be used for the project under consideration.

#### Evaluation of the Project at Shadow Prices

From the above discussion it follows that  $NB_m$  needs to be corrected for foreign exchange and semi-skilled/unskilled labour content of costs and benefits to arrive at the net benefits of the project at shadow prices ( $NB_s$ ). If  $(1 + X)$  denotes the shadow price of foreign exchange where  $X$  represents the foreign exchange premium which is positive in our case (+ 0.1) and is expected to remain constant over the lifetime of the project, and  $(1 + Y)$  denotes the shadow price of semi-skilled/unskilled labour where  $Y$  represents the premium on semi-skilled/unskilled labour which is currently negative (-0.04) and

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<sup>6</sup>The Reserve Bank's unemployment indicator series which is constructed by applying the trend in age and sex-specific participation rates (as revealed by census data) to current population data stood at 6.5 per cent at March 1978.

is expected to remain constant during the construction period of the project<sup>7</sup>, the net benefits at shadow prices in any given year of the project can be expressed as

$$\begin{aligned}
 \text{NB}_s &= \text{NB}_m + \text{XF} + \text{YL} \text{ --- (b)} \\
 \text{where } F &= - (a_1) - (a_2) + (a_3) + (a_4) \\
 L &= - (d_1)
 \end{aligned}$$

$\text{NB}_s$  - the net benefit at shadow prices - is obtained by adding two terms to the market estimate,  $\text{NB}_m$ . The first term corrects  $\text{NB}_m$  for the shadow price of foreign exchange by multiplying the net foreign exchange component of costs and benefits,  $F$ , by the foreign exchange premium,  $X$ . The second term makes a similar correction for semi-skilled/unskilled labour but only for the component of capital costs,  $L$ . No adjustment has been made for semi-skilled/unskilled labour component of fixed costs as it is difficult to judge whether the present unemployment situation will persist over the lifetime of the project. However the effect of this on the NPV of the project is negligible.

Since shadow prices have been assumed to be constant over the relevant period of time, there is no need to make separate adjustments in costs and benefits for each year of the project. As mentioned earlier the present value of each cost and benefit flow from Table 36 can be substituted in equation (b) in order to compute the net contribution of the project to the nation. The present value of  $\text{NB}_s$  at the social rate of discount of 10 per cent turns out to be positive at approximately \$20.362 million which is higher than the present value of  $\text{NB}_m$ .

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<sup>7</sup>In principle, each shadow price is a function of time, and the appropriate values may change according to the year in which costs and benefits are measured. However, due to the difficulties in assessing these changes and to simplify the computations, the assumption of constancy is made.

This is due to: (a) the extra foreign exchange benefits of the project; and (b) the lower wage bill for semi-skilled/unskilled labour. Finally the present value of  $NB_s$  at 20 per cent and 30 per cent discount rates are approximately + \$4.434 million and - \$1.702 million respectively, which show the sensitivity of the project to these variations in the discount rates.

### Sensitivity Analysis

Whatever method or combination of methods is used, future estimates of costs, benefits and shadow prices necessarily involve certain assumptions and probabilities. Many factors relating to them are not apparent and can never be fully accounted for. In short, actual values of costs, benefits and shadow prices may deviate from the estimated values due to many factors of which the most significant are:

- (a) Errors in base data.
- (b) Inadequacy of data.
- (c) Unforeseen economic and socio-political developments.
- (d) Unquantifiable factors and relationships.
- (e) Unrealistic or imprecise assumptions.
- (f) Technological changes.

The objective of sensitivity analysis is to investigate the impact of possible deviations on the NPV of the project. The method involves varying the values of the more important variables, singly or in combination, by a certain percentage to determine how sensitive the outcome of the project is to such changes. The number of variables to be tested in this manner is a matter of judgement. The sensitivity of the project under consideration is tested at + 10 per cent change in the total cost<sup>8</sup> (capital costs & fixed costs), and at  $\pm$  15 per cent change in the benefits to farmers. These two variables are tested

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<sup>8</sup>The costs are varied by 10 per cent rather than 15 per cent because the techniques used in freezing works are long-established and the consulting firm has vast experience in this field, and therefore, deviations from estimated costs are expected to be low.

Table 37. Sensitivity Analysis of the Project

(\$000's)

Variable		NPV at 10% discount rate		NPV at 20% discount rate		NPV at 30% discount rate		IRR (%)	
Total Cost (C + F)	Benefits to Farmers	Market prices	Shadow prices	Market prices	Shadow prices	Market prices	Shadow prices	Market prices	Shadow Prices
0	0	17,356	20,362	2,840	4,334	-2,563	-1,702	24.15	26.19
+10%	0	15,736	18,734	1,456	2,943	-3,796	-2,942	21.98	23.91
0	+15%	21,923	25,373	5,149	6,867	-1,203	- 211	27.32	29.54
0	-15%	12,789	15,350	531	1,800	-3,923	-3,194	20.80	22.66
+10%	+15%	20,303	23,745	3,765	5,476	-2,436	-1,450	24.97	27.07
+10%	-15%	11,169	13,722	- 853	409	-5,156	-4,434	18.81	20.56

Source: Computed from Table 35.

individually and also in combination at different rates of discount. The results are shown in Table 37. To provide more comprehensive conclusions, IRRs are also placed side by side.

The NPV at original estimates (i.e. zero change from market prices) is shown to facilitate the comparisons. It is interesting to note that at all possibilities tested at the suggested social rate of discount of 10 per cent, the NPV remains positive. The results indicate that the outcome of the project is particularly sensitive to the variable *benefits to farmers*.

No detailed sensitivity analysis is carried out with respect to shadow prices as their effect is relatively small and therefore, does not modify the conclusions of the analysis. For example, the outcome of the project tested at 5 per cent and 15 per cent weighting on the foreign exchange component of costs and benefits (weight on labour remaining the same) gives the NPV discounted at 10 per cent at \$18.933 million and \$21.791 million respectively - a marginal change from \$20.362 million. However if the rate of unemployment increases and/or the deficit in the balance of payments worsens, the net benefits from the project will be further enhanced.

CHAPTER 13CONCLUSION

In view of its importance to the economy, the development of the freezing industry has been controlled and guided by government since the depression of the 1930's. At present, the erecting of any new freezing works is conditional on the granting of a licence by the Meat Industry Authority which requires the applicant to prove that the proposal will lead to a rational allocation of resources on a national basis. Thus the firm not only has to ensure that the project earns an acceptable rate of return but also has to convince the Authority of its viability from the nation's view point. It was evident during recent licencing hearings before the Authority that the applicants found it difficult to show the contribution of their respective proposals to the national economy. Many opinions were expressed but no comprehensive quantitative estimates were presented on which decisions could be made. As stated at the outset, the main purpose of this case study has been to suggest a methodology which could bring together *all* the relevant costs and benefits and present them in such a way that the Authority could take a national view of the project.

In evaluating the project through cost-benefit analysis, it soon became evident that much of the information needed for such a study would not be available either because the information did not exist or because the freezing industry was very reserved about divulging that information. Therefore, at many places, rough estimates, informed judgement and intelligent guesswork have been used. The quantification of cost to farmers due to killing delays presented particular difficulties

on account of subjective factors involved such as farmers' confidence decisions on carrying capacity, different management policies and so on. According to many farmers<sup>1</sup> monetary loss is only half the problem; it is the psychological effect of the uncertainty and worry that is much more demoralising. In calculating benefits to farmers, a farm case study approach has been adopted. Reservations concerning the interpretation of these benefits include not only the assumptions and inadequacy of data used but also the methodology applied.

Another difficulty arose in quantifying the effects of the project on the transport industry. It was impossible to estimate savings in transport cost, as it was not clear at which works the stock would be killed, and in what numbers, if the new chain was not established at Takapau. Since the effect on the transport industry is favourable, it is important to mention here that any value assigned to it will improve the present value of net benefits of the project. Further research is needed to assess transport benefits from locating freezing works in the stock-producing areas before any realistic estimates can be made.

Balanced against the monetary net benefits is the intangible cost of increasing off-season unemployment in the economy. From the social viewpoint, people feel better at work than on the dole. However, it has not been possible to quantify the net effect of employing less people for longer periods against employing more people for shorter periods. Moreover, it is disputable whether New Zealand's dependence on seasonal growth of pasture allows the possibility of extension of the killing season. On account of these factors, no value can be assigned to this intangible. In reality, this cost (if there is any) is likely

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<sup>1</sup>See "Address by N.W. Jack" (p. 18) in Massey University, Department of Agricultural Economics and Farm Management [1979].

to be so negligible as compared to the wide margin of benefits that it would have no effect on the viability of the project whatsoever.

Another fact that emerges from the foregoing analysis is that the social returns of the project under study are considerably higher than the private returns. Comparing Table 6 and Table 37, it is clear that even the most pessimistic social rate of return (i.e. 18.81% at market prices; 20.56% at shadow prices) is more than twice as large as the private rate of return (i.e. 7.88%). Moreover, it is interesting to note that at the social rate of discount of 10 per cent, the project is not viable from the point of view of the company proposing it, as the NPV turns out to be negative at a level of \$1.572 million. However, being a co-operative, the company justifies the project on the ground that it provides services to its supplier shareholders and other clients.

The reason for this wide divergence in rates of return lies in the fact that there is some difference in the items considered as costs and benefits in these two types of analyses and the approach towards their valuation also differs. For example, the main benefit to the company comes in the form of killing and processing charges, whereas, benefits to the nation come in the form of extra export earnings due to early sale, savings in transport cost and avoiding losses to farmers resulting from killing delays. Again, where financial analysis has considered tax on profit (45 per cent flat rate) as a cost to the company, no such tax is taken into account in cost benefit analysis. Further it should be noted that when these costs and benefits are valued at shadow prices, returns to the nation are further improved.

The most significant conclusion of this analysis which has already been made clear is that the project as proposed by HBFMC is highly beneficial to the nation. The margin on benefits is so large that there seems little probability that uncertainties and assumptions on which the analysis is based can make the project unviable. Since the project does not seem to be highly profitable for the private company, in the national interest it is suggested that government should make the project more attractive by offering finance on lenient terms.

However, this study does not purport to be a complete analysis of the rational allocation of resources. As the objective was to suggest an approach, no alternatives have been assessed (for example, the Pacific proposal). The only alternative that has been considered is the situation without the project and therefore, the results only indicate that the project in itself is viable from the nation's view point but whether this is the best proposal is not known. It is hoped that the analysis presented here will provide an impetus to further application of cost-benefit analysis in this field as an aid to the decision process.

APPENDIX 1NEW ZEALAND EXPORT RECEIPTS BY JUNE YEAR

(\$ million)

Year	Meat Industry	Wool Industry	Dairy Industry	All Others	Total
1969	394.4	226.1	211.4	168.9	1000.8
1970	501.8	228.6	240.9	193.2	1164.5
1971	507.1	206.1	260.9	219.7	1193.8
1972	546.8	252.5	326.8	261.0	1387.1
1973	715.0	436.3	310.1	311.7	1773.1
1974	679.3	371.4	314.1	383.1	1747.9
1975	603.7	286.1	316.1	451.9	1657.8
1976	842.9	512.1	473.5	662.0	2490.5
1977	1111.3	687.8	582.9	948.4	3330.4
1978	1174.7	619.2	619.8	1005.0	3418.7

Source: Compiled from Reserve Bank of New Zealand data.

DCF RETURN OF INDUSTRY  
( \$ 000 's )

Year		Net Cash Flow	Present Value	
			10%	9%
0	1977-78	- 40	- 40	- 40
1	79	- 60	- 55	- 55
2	80	-2875	-2376	-2420
3	81	-6900	-5184	-5328
4	82	-3769	-2574	-2670
5	83	+1590	+ 987	+1033
6	84	+1811	+1022	+1080
7	85	+1798	+ 923	+ 984
8	86	+1785	+ 833	+ 896
9	87	+1772	+ 752	+ 816
10	88	+1759	+ 678	+ 743
11	89	+1745	+ 612	+ 676
12	90	+1732	+ 552	+ 616
13	91	+1718	+ 498	+ 560
14	92	+1703	+ 448	+ 510
15	93	+1688	+ 404	+ 463
16	94	+1673	+ 364	+ 421
17	95	+1658	+ 328	+ 383
18	96	+1643	+ 296	+ 348
19	97	+8138	+1331	+1583
			- 201	+ 599

Year 19:

Residual value of  
Buildings & Structures - \$ 6510    (  $\frac{35}{50} \times 9300 = 6510$  )  
Ordinary Cash Flow        - \$ 1628  
  \$ 8138

DCF return or IRR        = 9.75%

Source: Calculated from Table 6 by making adjustments for premium and rebate.

APPENDIX 3COUNTIES IN THE SELECTED AREA BY REGIONSTaranaki

Clifton  
 Taranaki  
 Inglewood  
 Egmont  
 Stratford  
 Eltham  
 Waimate West  
 Hawera  
 Patea

Wellington West

Waimarino  
 Waitotara  
 Wanganui  
 Rangitikei  
 Kiwitea  
 Pohangina  
 Oroua  
 Manawatu  
 Kairanga  
 Horowhenua  
 Hutt

Wellington East

Pahiatua  
 Akitio  
 Eketahuna  
 Masterton  
 Wairarapa  
 Featherston.

Hawkes Bay

Hawkes Bay  
 Waipawa  
 Waipukurau  
 Dannevirke  
 Woodville

East Coast

Waiapu  
 Waikohu  
 Cook  
 Wairoa

South Auckland

Taumararua (50%)  
 Taupo (60%)

APPENDIX 4

Sheep Numbers By Counties  
(Year Ended 30 June)

COUNTY	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
<u>Taranaki</u>														
Clifton	197,950	221,163	231,538	230,154	217,453	204,734	192,713	198,535	189,934	180,790	174,308	167,646	187,236	197,452
Taranaki	75,569	78,368	78,014	65,768	60,165	56,551	46,406	51,094	42,345	41,227	37,838	39,366	44,868	45,993
Inglewood	149,772	162,860	160,724	161,853	155,102	150,701	137,939	141,641	127,344	129,321	117,259	116,635	121,013	130,649
Egmont	85,910	87,758	85,820	82,109	75,624	76,347	66,465	73,778	60,514	57,001	50,278	49,643	53,123	51,903
Stratford	415,921	454,203	479,721	476,823	467,095	450,242	422,024	430,896	426,853	400,241	389,354	387,533	390,128	420,017
Eltham	115,833	117,725	117,288	121,901	115,114	110,280	97,876	103,383	85,481	86,047	86,875	74,078	86,204	90,382
Waimate West	15,478	17,713	16,262	13,992	11,109	10,264	8,544	7,988	6,346	5,271	4,473	4,758	4,729	7,963
Hawera	162,798	173,500	177,207	171,783	149,742	157,581	145,792	177,694	134,026	130,583	130,459	132,277	135,022	151,567
Patea	422,724	463,762	490,887	489,748	486,146	469,826	443,640	432,907	396,161	389,628	364,378	344,947	375,062	413,715
<b>Total</b>	<b>1,641,955</b>	<b>1,777,052</b>	<b>1,837,461</b>	<b>1,814,131</b>	<b>1,737,550</b>	<b>1,686,526</b>	<b>1,561,399</b>	<b>1,617,916</b>	<b>1,469,004</b>	<b>1,420,109</b>	<b>1,355,222</b>	<b>1,316,883</b>	<b>1,397,585</b>	<b>1,509,641</b>
<u>Wellington West</u>														
Wairarino	504,150	521,318	549,131	547,877	537,090	521,611	512,098	512,386	481,747	499,501	488,208	490,909	516,490	552,263
Waitotara	315,590	335,342	348,775	334,125	334,505	332,282	309,105	307,551	290,801	293,835	279,520	281,967	299,533	329,715
Wanganui	596,622	645,687	670,528	683,936	685,424	661,958	619,072	651,544	609,659	570,571	579,592	586,102	605,864	638,764
Rangitikei	1,915,108	2,000,311	2,062,659	2,080,760	2,090,910	2,066,048	2,013,167	2,023,009	1,967,186	1,955,621	1,905,333	1,911,025	2,005,590	2,007,323
Kiwitea	553,587	583,022	600,666	611,092	595,459	612,749	595,205	623,100	564,518	557,717	541,249	535,063	571,165	598,281
Pohangina	306,677	326,824	337,259	345,360	334,892	334,837	326,060	338,065	314,662	306,685	304,997	303,870	286,181	304,839
Groua	441,852	460,405	474,618	448,720	450,144	428,466	399,956	451,924	396,522	373,916	347,630	369,997	390,987	410,436
Manawatu	315,075	325,933	321,117	299,541	284,665	255,750	231,178	243,629	213,532	190,027	171,487	181,321	204,486	217,357
Kairanga	230,517	233,609	247,136	237,008	226,986	211,872	188,220	197,563	169,523	189,603	143,950	151,531	163,517	178,346
Horowhenua	257,183	269,072	270,212	253,090	253,016	231,450	197,864	235,870	176,453	169,823	165,412	171,801	176,060	189,903
Hutt	218,050	248,773	269,058	268,584	273,896	253,438	236,290	251,535	237,881	209,410	201,869	188,076	209,637	218,944
<b>Total</b>	<b>5,654,411</b>	<b>5,950,295</b>	<b>6,151,159</b>	<b>6,110,093</b>	<b>6,066,987</b>	<b>5,910,461</b>	<b>5,628,215</b>	<b>5,836,176</b>	<b>5,422,484</b>	<b>5,316,709</b>	<b>5,129,247</b>	<b>5,171,662</b>	<b>5,429,510</b>	<b>5,646,171</b>
<u>Wellington East</u>														
Pahiatua	367,162	393,483	405,817	410,939	384,389	418,775	417,957	428,115	409,390	399,323	373,630	385,218	401,480	439,077
Akitio	358,260	363,419	390,344	395,678	412,986	408,596	425,183	448,765	411,824	405,161	424,171	419,029	435,532	415,514
Eketahuna	349,119	373,698	388,969	406,382	391,586	372,094	383,105	395,415	379,380	382,142	392,128	388,082	416,960	414,199
Masterton	936,686	965,247	1,026,972	1,070,646	1,053,821	1,087,393	1,069,367	1,155,913	1,105,738	1,170,469	1,131,031	1,161,158	1,267,012	1,227,009
Wairarapa	387,752	412,732	427,591	435,367	420,109	408,440	401,307	438,883	395,709	410,304	394,889	414,553	438,094	427,680
Featherston	715,882	708,043	720,280	717,008	709,335	698,380	678,126	751,417	704,885	742,865	705,697	705,312	749,074	702,195
<b>Total</b>	<b>3,114,861</b>	<b>3,216,622</b>	<b>3,359,973</b>	<b>3,436,020</b>	<b>3,372,326</b>	<b>3,393,678</b>	<b>3,375,049</b>	<b>3,618,508</b>	<b>3,406,926</b>	<b>3,510,264</b>	<b>3,421,546</b>	<b>3,473,352</b>	<b>3,708,152</b>	<b>3,625,674</b>

Hawkes Bay

Hawkes Bay	2,146,917	2,276,394	2,366,458	2,418,888	2,357,134	2,462,822	2,485,231	2,515,590	2,331,401	2,366,706	2,312,717	2,367,921	2,501,760	2,551,639
Waipawa	862,204	888,445	877,661	882,331	853,622	896,008	912,737	937,518	885,794	894,637	887,383	901,909	949,583	957,654
Waipukurau	264,978	271,226	282,874	292,078	285,494	289,304	261,744	294,117	278,489	287,740	1,478,498	1,547,655	1,616,267	1,622,944
Patangata	1,108,329	1,162,694	1,211,734	1,263,290	1,233,298	1,256,586	1,275,346	1,309,668	1,247,818	1,243,081				
Dannevirke	826,063	863,215	873,634	906,299	869,710	865,877	855,260	860,515	815,078	819,056	819,964	826,194	849,357	890,257
Woodville	237,991	241,136	254,712	254,806	247,420	251,856	239,738	233,005	214,176	217,657	205,846	211,389	209,818	227,276
Total	5,446,482	5,703,110	5,867,073	6,017,692	5,846,678	6,022,453	6,030,056	6,150,413	5,772,756	5,828,877	5,704,408	5,855,068	6,126,785	6,249,770

East Coast

Waipatu	619,948	629,385	675,370	706,606	659,688	682,784	666,303	648,737	636,652	638,963	619,927	643,330	634,179	660,049
Waikohu	683,226	673,132	728,296	734,268	700,635	717,232	694,342	700,897	694,930	712,643	694,727	727,466	763,791	785,328
Cook	1,016,177	1,081,217	1,154,055	1,160,147	1,136,184	1,182,955	1,149,286	1,135,651	1,108,831	1,148,915	1,124,817	1,174,086	1,207,070	1,272,259
Wairoa	803,891	846,845	914,393	950,735	921,906	976,256	964,406	1,000,795	986,590	994,933	980,936	986,801	1,074,996	1,106,024
Total	3,123,242	3,230,579	3,472,114	3,551,756	3,418,413	3,559,227	3,474,337	3,486,080	3,427,003	3,495,454	3,420,407	3,531,683	3,680,036	3,823,660

South  
Auckland

Taumarunui 50%	551,187	609,241	663,441	698,041	694,780	687,814	670,478	671,571	652,026	630,152	642,349	658,262	671,194	706,574
Taupo 60%	285,737	313,306	352,850	405,015	423,612	463,547	463,894	501,433	478,609	458,528	475,169	505,109	541,189	552,854
Total	836,924	922,547	1,016,291	1,103,056	1,118,392	1,151,361	1,134,372	1,173,004	1,130,635	1,088,680	1,117,518	1,163,371	1,212,383	1,259,428

Grand Total 19,817,875 20,800,205 21,704,071 22,032,748 21,560,346 21,723,706 21,203,428 21,882,097 20,628,808 20,660,093 20,148,348 20,512,019 21,554,451 22,114,344

North Island 29,617,727 31,757,694 33,464,572 33,765,909 32,880,127 32,891,115 31,426,096 32,214,664 29,929,726 29,396,405 28,379,591 29,007,685 30,878,519 32,517,000

Source: Department of Statistics "Sheep Returns"

APPENDIX 5FLOW OF BENEFITS TO FARMERS

(\$ 000's)

Year	Throughput (Lamb units)	Benefits to Farmers over Year					
		0-1	2	3	4	5-17	18
0-1	0	0					
2	497,000		833	2,088			
3	692,000			1,204	3,017		
4	799,000				1,390	3,484	
5-17	799,000					1,390	3,484
<b>Total</b>		0	833	3,292	4,407	4,874	3,484

Note: 1978-80 is referred to as year 0

Source: Throughput from Table 2 (reduced to lamb units).  
 Benefits in the immediate season = \$1.74/lamb unit.  
 Benefits in the following season = \$4.36/lamb unit.  
 (calculated on p. 132).

APPENDIX 6LONDON WHOLESALE PRICE OF N.Z. LAMB

(Mid-Monthly Comparison)

Month	NZ cents			
	1975-76	1976-77	1977-78	1978-79
October	125.9	166.5	176.1	231.3
November	129.8	170.4	184.1	213.0
December	136.2	186.5	187.0	209.7
January	139.4	194.2	192.6	214.2
February	131.3	166.9	184.5	202.6
March	130.1	164.1	181.2	201.2
April	133.7	160.2	180.8	
May	147.1	164.4	192.6	
June	148.5	165.1	201.6	
July	146.6	159.9	216.0	
August	150.9	158.9	215.6	
September	160.7	165.8	219.6	

Source: "The New Zealand Meat Producer" - a monthly publication of NZ Meat Producers Board.

NET PRESENT VALUE MANIPULATION

It was suggested in Chapter 12 that applying an adjustment factor to present values is equivalent to the traditional approach of applying a conversion factor to individual annual values. This appendix proves firstly that conversion factors may be applied to either the annual or present values, secondly that adjustment-factor and conversion-factor approaches are equivalent.

The basic equation is

$$NPV_j = \sum_{i=1}^n d_i f_{ij} \quad (1)$$

where  $NPV_j$  is the net present value at market prices over  $n$  years of input or output  $j$ ;  $d_i$  is the discount factor in year  $i$ , and  $f_{ij}$  is the value in year  $i$  of input or output  $j$ . Therefore, the net present value at market prices for the project as a whole with  $m$  inputs and outputs is

$$NPV = \sum_{j=1}^m NPV_j = \sum_{j=1}^m \sum_{i=1}^n d_i f_{ij} \quad (2)$$

The net present value at shadow prices for which the conversion factor is  $c_j$ , is given by

$$\overline{NPV}_j = \sum_{i=1}^n c_j d_i f_{ij} \quad (3)$$

If  $c_j$  is constant over time, (3) may be rewritten as

$$\overline{NPV}_j = c_j \sum_{i=1}^n d_i f_{ij} \quad (4)$$

Equations (3) and (4) show that the conversion factor may be applied either to the individual annual values or to the net present value of each input and output.

For the project as a whole, the net present value at shadow prices is

$$\overline{\text{NPV}} = \sum_{j=1}^m c_j \sum_{i=1}^n d_i^f i_j \quad (5)$$

Substituting from (1) to (5)

$$\overline{\text{NPV}} = \sum_{j=1}^m c_j \text{NPV}_j \quad (6)$$

$$\text{or } \overline{\text{NPV}} = \sum_{j=1}^m [c_j \text{NPV}_j + \text{NPV}_j - \text{NPV}_j]$$

$$\text{or } \overline{\text{NPV}} = \sum_{j=1}^m [\text{NPV}_j (c_j - 1) + \text{NPV}_j]$$

From (2), it becomes

$$\overline{\text{NPV}} = \text{NPV} + \sum_{j=1}^m (c_j - 1) \text{NPV}_j$$

By definition

$$a_j \equiv c_j - 1 \quad (\text{a} = \text{adjustment-factor})$$

Therefore,

$$\overline{\text{NPV}} = \text{NPV} + \sum_{j=1}^m a_j \text{NPV}_j \quad (7)$$

The above proves the equivalence of conversion and adjustment factors.

For simplicity, let us define shadow price adjustment  $e_j$  as follows:

$$e_j \equiv a_j \text{NPV}_j \quad (8)$$

which reflects the premium or discount required to move from market evaluation to shadow prices evaluation. Substituting (8) into (7) gives

$$\overline{\text{NPV}} = \text{NPV} + \sum_{j=1}^m e_j$$

i.e. the net present value at shadow prices of the project is equal to its net present value at market prices plus the sum of any adjustments that are required. (The above mathematical proof is given in UNIDO, 1978a, pp.95-96.)

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