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THE REGIONAL IMPACTS OF IRRIGATION DEVELOPMENT IN THE LOWER WAITAKI

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RESEARCH REPORT NO. 99

SEPTEMBER, 1979

ISSN 0069-3790

THE AGRICULTURAL ECONOMICS RESEARCH UNIT
Lincoln College, Canterbury, N.Z.

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PREFACE

This study has been carried out as part of the AERU's research programme concerning resource economics. This programme is aimed at encouraging efficient resource use and development in terms of both regional and national policy objectives.

More specifically, the current study highlights the regional implications of a large scale government funded Irrigation Scheme in the Lower Waitaki basin of the South Island. Considerable attention has been given in this study to alternative methods of estimating regional multipliers for the appropriate region.

The methodology developed in this study should form the basis of further future analyses aimed at quantifying regional impacts of investment projects. In this respect alone, the current report is most timely as increasing attention is being given in New Zealand to regional development matters.

J.B. Dent
Director

ACKNOWLEDGEMENTS

The authors would like to thank the Water Resources Council for providing financial assistance for this study.

The assistance of the Ministry of Works and Development, the Department of Statistics, the Ministry of Agriculture and Fisheries and the Department of Labour is also gratefully acknowledged for supplying information and data used in the study. In particular, thanks are due to Mr Mike Burns of the Ministry of Works and Development, Christchurch, for data on the construction of the Morven-Glenavy scheme; Messrs Murray Elliott and John Oliver of the Ministry of Agriculture and Fisheries at Oamaru and Waimate, respectively, for their help in ascertaining the effect of irrigation on agriculture in the Lower Waitaki area; and Ms S. Lee of the Ministry of Agriculture and Fisheries, Christchurch, for her assistance with the survey of farmers on the Morven-Glenavy irrigation scheme.

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INTRODUCTION

1.1 Aims of the Study

Government expenditure on the development of Community Irrigation Schemes in New Zealand has, over the years, involved considerable sums of public money. Because of this, it has been usual for the Government to estimate the national benefits and costs associated with planned irrigation projects to ensure such schemes are in the national interest. Little attention, however, has been paid to the impacts that such irrigation developments may have on the economy of particular regions, an aspect which is becoming increasingly important with current disparities in regional population and employment levels (Brown, 1978). The aim of this study, therefore, is to provide some information in this field, examining, in terms of output, income and employment, the regional impacts of the irrigation developments which have occurred in the Lower Waitaki basin.[1]

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[1] The only existing study that has examined the regional impacts of irrigation development in New Zealand is that by Galway (1977).

Irrigation development in any area is likely to stimulate economic activity, initially through construction expenditures and then through scheme operating expenditures and increased levels of agricultural output and farm inputs. These stimuli are transmitted through to other sectors of the economy, and the overall increase in economic activity will lead to higher levels of local output, income and employment. These regional output, income and employment impacts are the result of multiplier effects that arise primarily as a consequence of interdependencies in the structure of the local economy. The estimation of these localised multiplier effects is of major importance if the regional impact of irrigation development is to be quantified. Hence, a considerable part of the present study is devoted to the estimation of regional multipliers for the Lower Waitaki area. Having obtained multiplier estimates, they are used to estimate the overall impact on the regional economy of the initial stimulus created by the irrigation development.

1.2 Types of Effects

In assessing the overall impact on an economy of a public works investment programme, various types of effects can be identified - direct, indirect, induced and external. Direct (or primary) effects are represented by the immediate benefits and costs associated with the investment. For example, in irrigation development the increase in agricultural production constitutes a direct benefit and the construction expenditure a direct cost. Indirect effects are generated by the direct effects as a consequence of inter-dependencies in the structure of the economy. Examples relevant to the present study are the extent to which increased agricultural production affects the servicing and processing industries. Induced effects arise as a result of the increase in personal expenditure created by the investment. For example, higher farm incomes generated by irrigation development can be expected to lead to increased expenditure on consumer goods and services. External effects, or externalities, are less tangible than direct, indirect, and induced effects and, as such, are considerably more difficult to quantify. Examples in irrigation development may be the opportunity of spending a leisurely afternoon fishing in an irrigation race, or the possibility of finding that, because of interference with the natural drainage in the area, a farm doubles as the local reservoir.

The present study concentrates on the indirect and induced effects arising from irrigation development. Together these will be referred to as secondary effects.

1.3 Secondary Effects

In this section the nature of the indirect and induced effects, which combine to form the secondary effects, is outlined in greater detail.

Indirect effects occur because all sectors in the economy are, to a greater or lesser extent, interdependent. The effect on the economy of an increase in agricultural production, for example, does not stop at the farm gate. On the output side, as the increased production works its way through from farmer to final consumer, the demand for transport, marketing and processing services etc., will increase[2]. On the input side, increased agricultral production can be expected to increase the demand for fertilizers, seeds, farm machinery, etc. However, these linkages are not confined solely to those industries or sectors of the economy that are directly associated with the farm sector. The increase in demand for fertilisers, for example, will usually mean that the fertiliser industry will need to increase its output and, as a corollary, its demand for inputs. In turn, the industries supplying these inputs will themselves need to expand output and so on.

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[2] That someone wants to buy the increase in farm output is assumed to be a prerequisite of the decision to invest in irrigation.

Together, these increases in production constitute the indirect impact of the initial increase in agricultural production. This indirect impact can be thought of as technical in nature in that, given the infrastructure of the economy, an increase in agricultural production requires, or is associated with, increased production in other sectors of the economy.

In the literature, indirect effects are sometimes divided into those that 'stem-from' and those that are 'induced-by' the direct effects, depending on whether they originate from industries that are associated with supplying the inputs or from industries that are associated with handling the output. For example, with irrigation development, the production increases transmitted throughout the economy as a result of an increase in the demand for fertilizer would be <u>induced-by</u> the increase in agricultural production. On the other hand, the indirect impact on the economy of production increases resulting from the demand for more transport services will <u>stem-from</u> the initial increase in agricultural production. Though this distinction between induced-by and stemming-from effects may sometimes be useful, the induced-by component should not be confused with the induced impact which, as shown below, relates to household income.

In addition to the indirect effects generated by the direct impact, an induced effect will also tend to increase production in various sectors of the economy. The induced effect is initially a function of consumer spending, and relates to the increase in personal income that is concomitant with increased production in the economy. The proportion of the increase in personal income that is spent leads to an increase in the demand for consumer goods and services. In response to this increased demand, the industries supplying consumer goods and services increase their production and, as with the indirect effect, these increases then generate further output and income in other sectors of the economy.

In increasing output and personal income, the indirect and induced effects may also create employment opportunities, depending on the extent to which existing capacity in the economy is being utilized. Within a region, secondary effects can generally be expected to lead to increases in output, income and employment[3], although these regional benefits cannot necessarily be regarded as national benefits, for reasons explained in the following section.

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[3] The present study ignores secondary costs. An example of a secondary cost in irrigation development could be the loss of business incurred by transport firms involved in the cartage of hay, since with irrigation the demand for bought in feed is reduced and, with it, the demand for transport in its cartage. It is felt that costs of this kind will be minimal with investment in irrigation and that by far the major secondary effect will be a stimulus to the local economy.

1.4 Traditional Investment Appraisal

Secondary effects have been largely ignored in traditional investment appraisal for two reasons. Firstly, from the national viewpoint secondary effects cannot produce a net increase in economic activity under the assumption of full resource employment. Any net increase in economic activity in a particular region will be matched by a decrease elsewhere, since all resources in the economy are fully utilized. That is to say national aggregate output cannot be increased, although its distribution between regions can be affected by different investment programmes.

Secondly, from the regional viewpoint - and, presumably, from the national viewpoint at times when resources are not fully employed - it has been assumed that the secondary effects arising from any public works investment programme will be similar. However, such a situation only rarely occurs, for generally investment in one sector will have markedly differing regional impacts than investment in another. For instance, electricity development is capital intensive, and while it may generate a large number of short-term employment opportunities during the construction phase, the long term employment impacts are small. Conversely, investment in the agricultural sector may provide continuing employment opportunities both within the sector itself and, through the secondary effects, in sectors which are associated with either providing inputs or servicing the product.

As a result of these two assumptions, decisions on the allocation of resources between alternative investments in New Zealand have been, and still are, made solely on an evaluation of the direct effects, usually assessed through cost-benefit analysis. Net direct benefits, expressed in the form of Net Present Value or an Internal Rate of Return, are used to rank investments in terms of efficiency; that is, in terms of increasing aggregate output in the national economy. Cost-benefit studies of the two main irrigation schemes in the Lower Waitaki area - the Morven-Glenavy and the Lower Waitaki schemes - were undertaken by the Ministry of Agriculture & Fisheries (M.A.F.) in the late 1960's.[4] These studies showed direct benefits to exceed direct costs (see Table 1), and the irrigation development proceeded.

Table 1

Results of Cost-Benefit Studies[a]

	Lower Waitaki Scheme ($)	Morven-Glenavy Scheme ($)
Direct Benefits	5,119,528	2,487,575
Direct Costs	3,976,311	2,236,372
Net Present Value[b]	1,143,217	251,203
Internal Rate of Return	7.72%	≏ 6.6%

[a] 10 year development period and 'realistic' prices assumed.
[b] 6% discount rate assumed.

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4 See Appendix 1 for discussion of the approach adopted by MAF in cost-benefit analysis.

The present study assesses the impact that the two schemes have had on the local economy, and in this respect the estimation of regional multipliers for the Lower Waitaki area is of major importance.

1.5 Multipliers

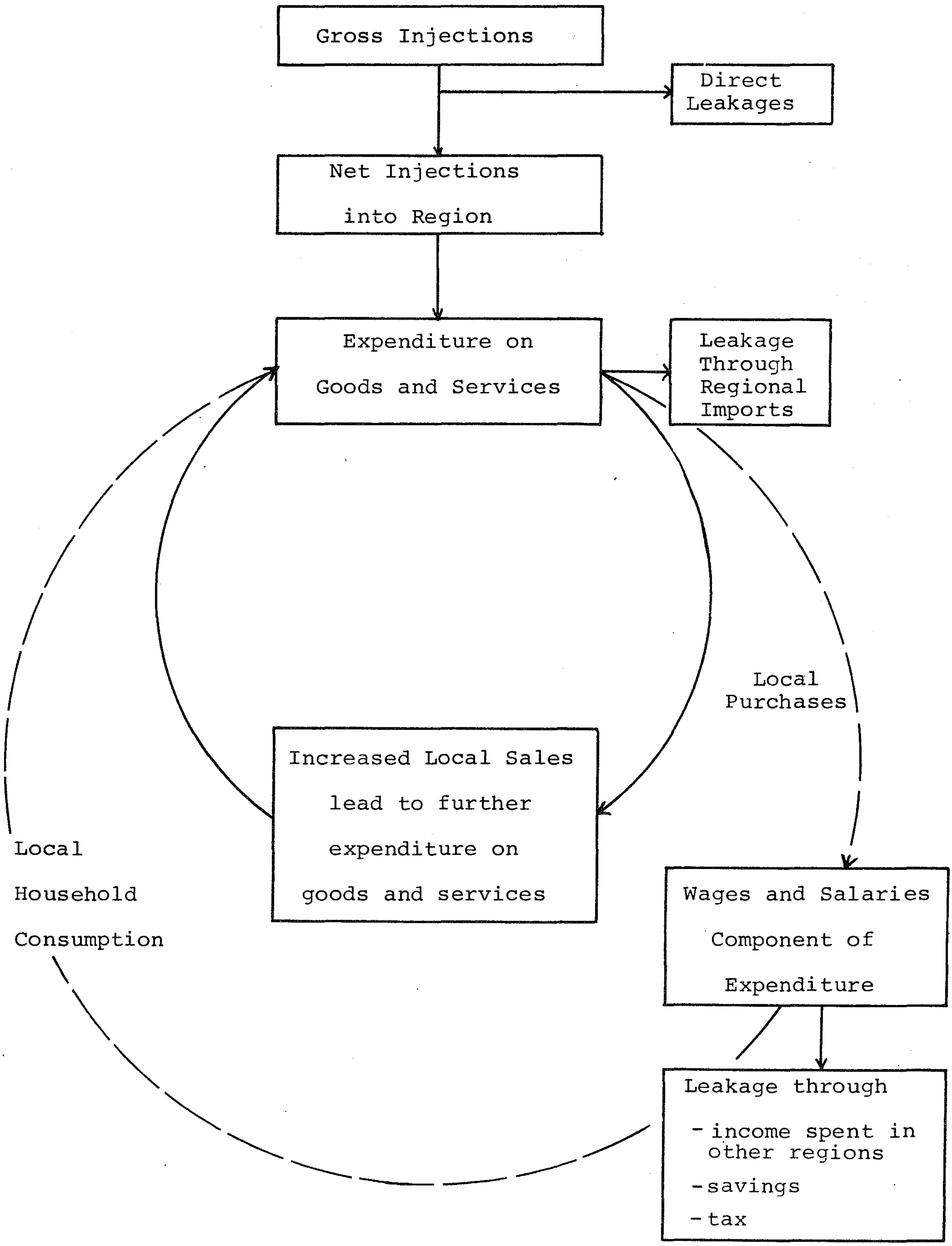
A multiplier is a measure of the total impact on an economy generated by an initial expenditure injection. In the present study, the successive rounds of output, income and employment created by the indirect and induced effects can be measured using output, income and employment multipliers. The size of these multipliers, and hence the secondary effects, is determined by 'leakages' from the economy through savings, taxes and imports. The greater these leakages, the smaller the multiplier effects will be.

At the regional level, multiplier effects are markedly reduced by a greater dependence on imports. A region will be more dependent than the nation on imports because, as well as having to import goods and services from other countries, it will also have to 'import' from other regions those domestically produced goods and services in which, as a region, it is deficient. This follows from the economics of location. Generally, the smaller the region, the greater is likely to be the dependence on imports and, consequently, the smaller the multiplier effects. Conversely, for progressively larger regions the dependence on imports is reduced up to the point at which 'the region' becomes the nation and the regional multiplier assumes a national value. Regional multiplier effects are shown diagramatically in Figure 1 and are examined in detail in later chapters.

The remainder of this report is arranged as follows. In Chapter 2, the Lower Waitaki region is described and defined for the purpose of the present study. In Chapter 3, the net injections associated with the irrigation development in this region are quantified. Chapters 4, 5 and 6 concentrate on the estimation of regional multipliers. In Chapter 4, export-base theory is outlined and applied to data for the Lower Waitaki region to derive export-base output multipliers. In Chapter 5 a simple Keynesian income determination model is used at the regional level to estimate an income multiplier. And in Chapter 6, a technique of deriving a non-survey regional input-output model enables the estimation of output, income and employment multipliers through input-output analysis. In Chapter 7, the most appropriate multiplier estimates from these three methods are combined with the net injections from Chapter 3 to derive estimates of the total output, income and employment impacts in the region. The summary and conclusions are presented in Chapter 8.

Figure 1

Diagramatic Representation of Regional Multiplier Effects



CHAPTER 2

THE LOWER WAITAKI REGION

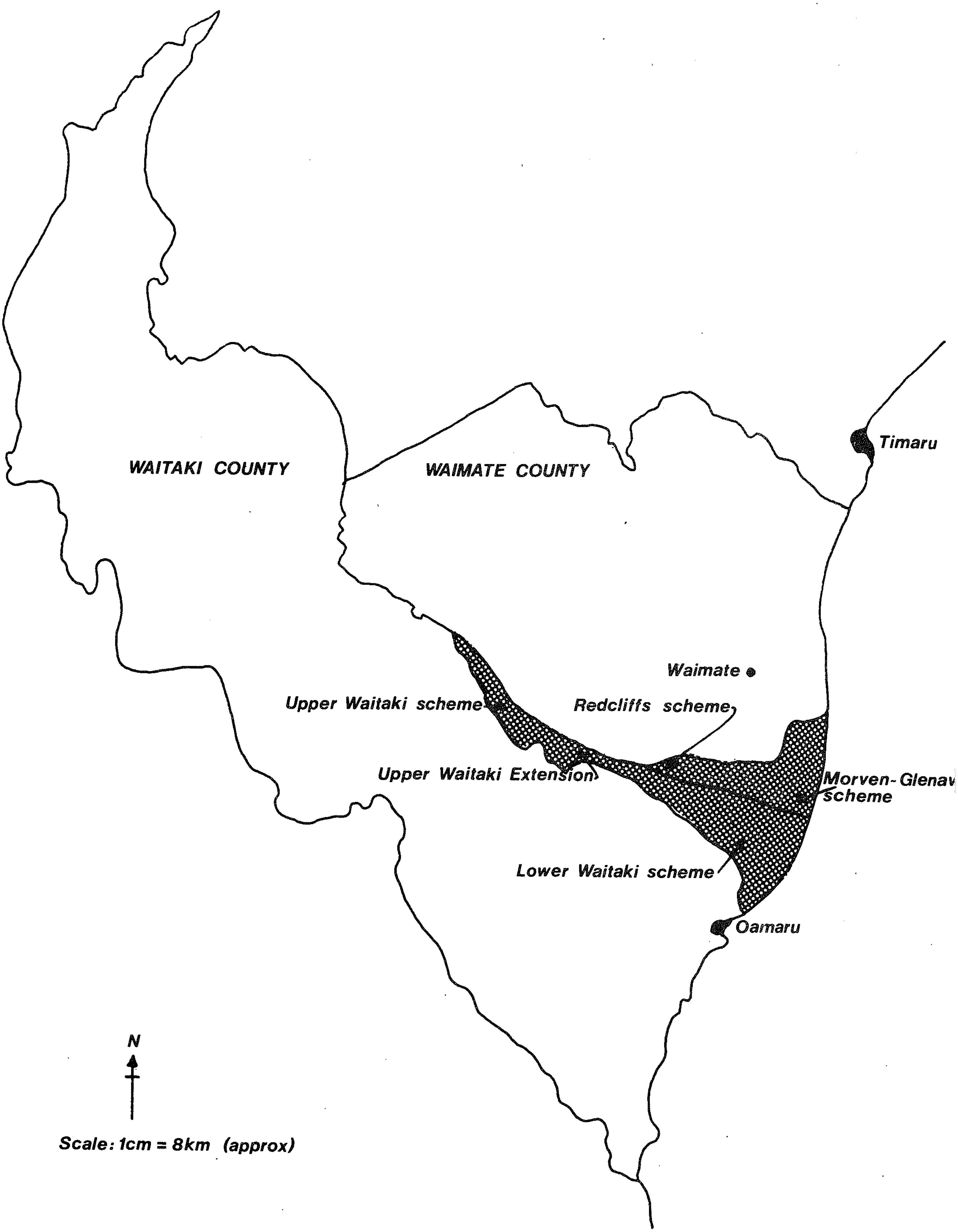
The study area encompasses five irrigation schemes around the mouth of the Waitaki river. In the East, the river serves as a county and Statistical Area (S.A.) boundary, separating Waimate County (Canterbury S.A.) from Waitaki County (Otago S.A.). Oamaru to the South and Waimate to the North are the nearest major towns (see Figure 2). The five irrigation schemes are:

Scheme	Construction Date	Area Commanded
North Bank of Waitaki River		ha
Morven-Glenavy	1970-78	12,150
Redcliffs	1938	2,400
South Bank of Waitaki River		
Lower Waitaki	1970-79	14,500
Upper Waitaki	1962-65	1,380
Upper Waitaki Extension	1968-70	450
		30,880

These schemes have a combined commanded irrigable area of 31,000 ha with the Morven-Glenavy and Lower Waitaki schemes, the two major ones, accounting for 86 per cent of this. All, except the Redcliffs scheme, were promoted under the 1960 Amendment to the 1928 Public Works Act.

Figure 2

Irrigation Schemes in the Lower Waitaki



Construction on the Morven-Glenavy and Lower Waitaki schemes began in 1970 and, as neither scheme is as yet fully operational, the present study has been confined to assessing the secondary impact of these two schemes on the economy of the Lower Waitaki area up to 1977/78.

The populations of Waitaki and Waimate counties, and Oamaru and Waimate boroughs in each of the last three census years are shown in Table 2. The intercensal changes show a net out-migration between 1966 and 1971, but a net in-migration

Table 2

Population - Waimate, Oamaru and Waitaki

	Population			Change	
	1966	1971	1976	1966-71	1971-76
Waimate borough	3,300	3,228	3,378	-72	+150
Waimate county	9,226	8,574	8,835	-652	+261
Oamaru borough	13,194	13,084	13,480	-110	+396
Waitaki county	25,473	22,503	22,576	-2,970	+ 73

Source: Dept of Statistics, Census of Population and Dwellings 1966, 1971 and 1976.

over the five years to 1976. The Department of Statistics internal migration figures show that of persons moving from the area during the 1966-71 period the majority were in the lower age groups.

Out-migration from a region invariably entails a loss of income to that region - if only by the amount of unemployment benefit foregone. This loss of income can, through the workings of the regional multiplier, exert a destabilising influence on the local economy by causing unemployment and further losses in income[5]. However, the census results in Table 2 show a reversal in population movements over the five year period 1971-76. This can be attributed partly to the deteriorating national economic climate in the first half of the present decade, when labour mobility was probably reduced as a result of fewer alternative employment opportunities.

One of the first requirements of any regional study is a definition of 'the region'. Since the present study relies heavily on the use of secondary data from official sources, the region has to be defined so as to correspond to administrative areas. Waimate and Waitaki counties have therefore been chosen to represent the immediate region surrounding the Lower Waitaki irrigation schemes. However, in the estimation of regional multipliers in Chapters 4, 5 and 6, lack of sufficiently detailed data at the county level means that this regional definition can not always be adhered to, and in Chapter 7, the estimated total output, income and employment impacts refer, in the main, to the region encompassed by the Otago S.A. and Waimate county.

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[5] See Archibald (1967) for illustration of this destabilising influence.

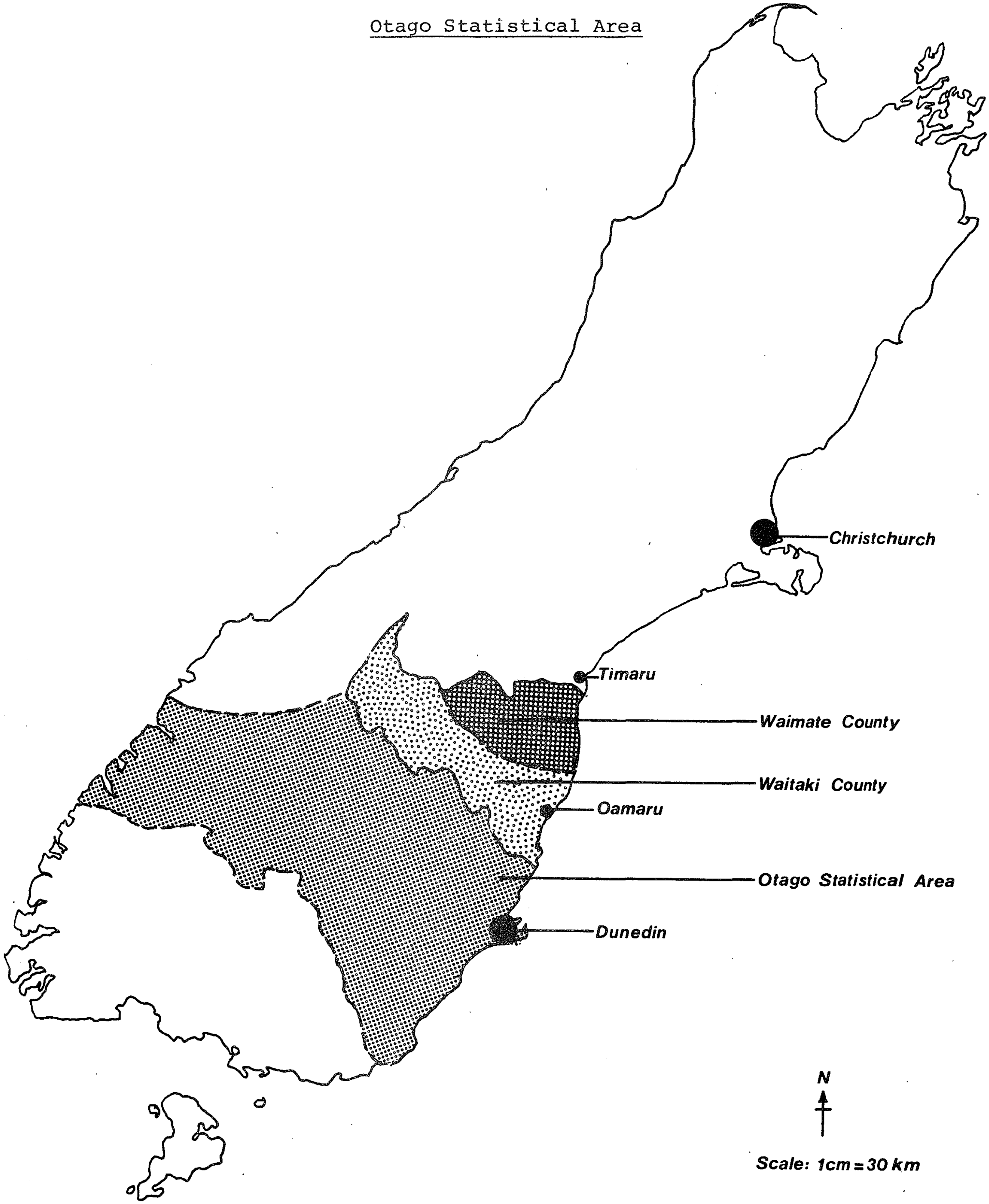
Economic regions are unlikely to coincide with counties, Statistical Areas, or the like, but unless the researcher resorts to the collection of primary data, this problem remains common to most, if not all, regional studies. The regional boundaries used in the present study are shown in Figure 3.

Having defined the bounds of the region under study, it is necessary to estimate the injections, resulting from the irrigation development, that act as an initial stimulus to the local economy. These injections are estimated in the following chapter.

Figure 3

Waimate & Waitaki Counties and the

Otago Statistical Area



CHAPTER 3

INJECTIONS INTO THE REGIONAL ECONOMY

It has been stated that investment in a region will result in increased economic activity over and above the direct effects. A first step in estimating this secondary impact is to calculate the injections into the local economy that are likely to generate, via the regional multiplier effects, additional output, income and employment.

Investment in irrigation will give rise to direct injections in three main areas:

1) Construction expenditures — off-farm / on-farm
2) Operation and maintenance expenditures
3) Increased agricultural production

The injections outlined in this chapter pertain to the Morven-Glenavy and Lower Waitaki irrigation schemes. Figures on off-farm construction and operation and maintenance expenditures have been supplied by the Ministry of Works and Development (M.W.D.) for the eight years since 1970/71. Estimates of the increase in agricultural production and the on-farm construction expenditures are based largely on farm surveys conducted on the two schemes in November/ December 1978. The survey of farms on the Morven-Glenavy scheme, undertaken by the Agricultural Economics Research Unit (A.E.R.U.) sought data that related only to the 1977/78 season. However, the Lower Waitaki survey, undertaken by the M.A.F., collected data relating to the period 1972/73 - 1977/78 and an attempt has been made to estimate the annual increases in agricultural production and the on-farm construction expenditures for both schemes since they first became operational.

3.1 Construction Expenditure

3.1.1. Off-farm expenditure. Construction of both the Morven-Glenavy and Lower Waitaki schemes was started by the M.W.D. in 1970/71. Capital expenditure to 1977/78 totalled \$8m. A breakdown of this off-farm expenditure is given separately for the two schemes in Table 3.

Of the \$5m spent on the construction of the Lower Waitaki scheme, two-thirds has been paid to private contractors. On the Morven-Glenavy scheme a greater proportion of the construction has been undertaken by the M.W.D. Overall, slightly more than half of the total expenditure of \$8m has been put out to tender.

When treating this capital expenditure as an injection into the local economy, a difficulty arises in not knowing how much accrues to persons and firms in the regions and how much to persons and firms outside the region; that is in not knowing how much is immediately 'leaked' from the region. If, with the construction put out to tender, local contractors are engaged employing local labour, then this capital expenditure can be considered an injection into the regional economy. (Subsequent indirect leakages of income from the region through the purchase of imports will be accounted for in the regional multipliers - refer to Figure 1). However, if at the other extreme, the contractors are non-local firms whose employees commute to 'the region' everyday, then very little of the capital expenditure can be claimed to be an injection into the local economy. Between these two extremes exists a variety of cases where, to a greater or lesser extent, part of the initial expenditure will accrue directly to non-local firms and employees and thus have no effect in stimulating the regional economy. This situation is further complicated by instances of sub-contracting.

From information supplied by the M.W.D., it would appear that of the construction put out to tender, about 65 per cent or $2.8m was undertaken by firms based in Oamaru or Waimate. This then would clearly be an injection into the economy of the region represented by Waimate and Waitaki counties. Of the remaining 35 per cent, undertaken by non-local contractors, some expenditure would also have entered

Table 3

Off-farm Construction Expenditure 1970/71-1977/78

Year	Capital Expenditure	Breakdown of Expenditure ($)		
	$	Salaries and Wages (MWD)	Other MWD Expenditure[a]	Contracts
		Morven-Glenavy Scheme		
1970/1	126,000	25,200[b]	100,800[b]	-
1971/2	113,800	10,100[b]	40,300[b]	63,400
1972/3	596,700	42,500[b]	170,000[b]	384,200
1973/4	656,900	101,500	351,100	204,300
1974/5	565,600	101,700	366,400	97,500
1975/6	561,300	81,700	373,800	105,800
1976/7	330,900	56,100	229,300	45,500
1977/8	164,000	23,800	134,500	5,700
TOTAL	3,115,200	442,600	1,766,200	906,400
		Lower Waitaki Scheme		
1970/1	251,300[c]	15,900	67,000	168,400
1971/2	664,500[c]	42,100	177,200	445,200
1972/3	580,300[c]	36,700	154,800	388,800
1973/4	574,100	36,300	153,100	384,700
1974/5	581,800	36,800	155,200	389,800
1975/6	999,900	63,300	266,700	669,900
1976/7	765,900[c]	48,500	204,200	513,200
1977/8	549,100[c]	34,800	146,400	367,900
TOTAL	4,966,900	314,400	1,324,600	3,327,900
GRAND TOTAL	8,082,100	757,000	3,090,800	4,234,300

[a] Includes materials, hire of plant and trucks, vehicle running etc.

[b] Capital expenditure apportioned using the average breakdown over 1973/4-77/8 as figures prior to 1973/4 not available.

[c] Capital expenditure on the Lower Waitaki Scheme is apportioned to 'salary and wages', 'other' and 'contracts' using the average breakdown over 1973/4-1975/6 as annual breakdown not available.

Source: Data supplied by M.W.D.

the regional economy through the purchase of local goods and services. The estimate of this component can be little more than arbitrary and the present study assumes a figure of 25 per cent. So, of the construction undertaken by private contractors, approximately 75 per cent, or $3.2m, is estimated as an injection into the Waimate-Waitaki region.

As for the construction carried out by the M.W.D. itself, one half of the expenditure, or $1.9m, was estimated to accrue to the region, through locally purchased materials, local plant and truck hire and the employment of local labour (including the locally spent income of non-local labour).

Together these local injections sum to $5.1m. The remaining $3.0m of total construction expenditure is lost from the region through direct leakages.

3.1.2 On-farm expenditure. This part of the construction expenditure reprsents the development costs borne by the farmer. On-farm construction expenditure (including that for spray equipment) for the 1977/78 year, which totalled $870,000, is shown in Table 4.

Table 4

On-farm Construction Expenditure in 1977/78

	$
Morven-Glenavy Scheme	
Border-dyke	227,300
Spray	18,600
Lower Waitaki Scheme	
Border-dyke	371,200
Spray	252,700
TOTAL	869,800

Source: Farm Surveys (A.E.R.U. and M.A.F.)

Table 5 gives an estimate of the costs associated with border-dyke development on both schemes from 1970/71 - 1977/78. Apart from the 1977/78 figure, obtained from survey data, the costs have been estimated by multiplying the hectarage of border-dyke development in each year by a representative cost per hectare. Approximately 65 per cent of the latter accounts for earthworks (levelling and grading) and 35 per cent for in-race structures, fences, cultivation, fertilizers, etc. It is usual for local contractors to be employed to undertake part of this on-farm development, in particular the earthworks.

Table 5

On-farm Construction Expenditure 1970/71-1977/8

Year	Area Border-dyked: Morven-Glenavy	Area Border-dyked: Lower Waitaki	Estimated Cost per Hectare	Estimated Total Cost
	ha	ha	($)	($)
Prior 1972/3	-	3,110	180	559,800
1972/3	890	830	240	412,800
1973/4	1,140	970	300	633,000
1974/5	770	1,020	370	662,300
1975/6	580	400	400	392,000
1976/7	590	870	450	657,000
1977/8	380	750	-	869,800[ab]
Total border-dyked	4,350	7,950		4,186,700
	Area Developed for Spray Irrigation			
	ha	ha		($)
1972/3-76/7	750	2,400		1,000,000 [b]
Total area developed	5,100	10,350		5,186,700

[a] Includes spray irrigation - refer to Table 4.

[b] From farm survey data

Source: Farm surveys (A.E.R.U. and M.A.F.) and pers. comm. with M.A.F. officials at Waimate and Oamaru.

Total on-farm border-dyke development costs are estimated at just over \$4m to 1977/78. The cost per hectare has risen sharply over the period and, partly as a result of this, the rate of on-farm development has slowed considerably.

Expenditure relating to the investment made in spray irrigation over the period is also shown in Table 5. Together, expenditure on border-dyke and spray irrigation totals just over \$5m to 1977/78.

On-farm expenditure is subject to the same direct leakages as is off-farm expenditure. Non-local contractors and/or the purchase of materials from outside the region will reduce the injections into the local economy. From the knowledge available on the amount of construction work undertaken by farmers and local contractors, it has been assumed that on average 25 per cent of the on-farm expenditure is directly leaked from the Waimate-Waitaki region.

3.2. Operation and Maintenance Expenditure

Expenditure on the operation and maintenance of the schemes since 1970/71 is shown in Table 6. Of this expenditure, which includes the employment of racemen by the M.W.D., 80 per cent is assumed to be an injection into the local economy.

Table 6

Operation and Maintenance Expenditure on the Irrigation Schemes 1970/71 - 1977/78

Year	Operation and Maintenance Expenditure ($)		
	Morven-Glenavy Scheme	Lower Waitaki Scheme	Total
1970/1	-	-	-
1971/2	-	-	-
1972/3	-	-	-
1973/4	-	-	-
1974/5	8,500	-	8,500
1975/6	12,700	16,600	29,300
1976/7	30,500	48,700	79,200
1977/8	37,000	35,000	72,000
TOTAL	88,700	100,300	189,000

Source: Data supplied by the M.W.D.

3.3 Increased Agricultural Production

The cost-benefit studies undertaken to ascertain the direct effects from investment in irrigation schemes traditionally make a comparison on a 'with' and 'without' basis. Estimated agricultural production 'with' irrigation is contrasted with the dryland production 'without' irrigation and, when differences in costs are taken into account, these studies estimate the profitability of the schemes to the nation. In some of these cost-benefit analyses it has become usual to make an allowance for the likely increase in agricultural production under continuing dryland conditions. This type of allowance is not made in the present study since it was felt that no significant improvements in production, in terms of higher stocking rates and crop yields, would have occurred over the period 1972/73 - 1977/78 under dryland conditions[6].

The effects of irrigation on estimated gross farm revenue for the 1977/78 season are shown separately for the two schemes in Table 7. Total agricultural production of the farms within the Morven-Glenavy scheme was estimated at just under $2.5m in the 1977/78 season, an increase over the estimated dryland output of $660,000. Sheep provided the single most important source of farm income and

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6 This belief has been confirmed by M.A.F. officials in the region (see Appendix 2)

accounted for almost 80 per cent of the total gross farm revenue and 96 per cent of the increase in gross farm revenue[7].

Total gross revenue in 1977/78 from farms within the Lower Waitaki scheme was estimated at $4.7m of which almost 70 per cent was attributable to sheep. The increase in gross revenue was estimated at $1.8m and, as with the Morven-Glenavy scheme, over 90 per cent of this was due to increased output from sheep.

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7 The cropping/livestock mix is assumed to be the same under the 'with' and 'without' situations (see Appendix 2).

Table 7

Gross Farm Revenue - 1977/78

A Morven-Glenavy Scheme (64 farms)

	Under dryland conditions	Current situation with irrigation
	$	$
Cropping	528,800	549,800
Sheep	1,275,100	1,911,000
Total	1,800,900	2,460,800
Difference		659,900

B Lower Waitaki Scheme (133 farms)

	Under dryland conditions	Current situation with irrigation
	$	$
Cropping	1,329,400	1,483,600
Sheep	1,568,400	3,212,600
Total	2,897,800	4,696,200
Difference		1,798,400

Source: Farm surveys (A.E.R.U. and M.A.F.). See Appendix 2 for further details.

To gain some idea of the total additional gross farm revenue to date, increased agricultural output from both schemes over the period 1972/73 - 1976/77 was estimated simply in terms of increased sheep numbers. No account was taken of improved stock performance, increased production from cropping or changes in the pattern of farming. The area border-dyked in a particular year was assumed to be available for stocking at 16 stock units per hectare in the following year. As an approximate estimate of the increase in total gross farm revenue, the additional stock units carried in each year were multiplied by a gross revenue figure per ewe. Estimated additional gross farm revenue over the period 1972/73 - 1977/78 is shown in Table 8. The estimate of additional gross farm revenue for the 1977/78 season, in this table, is that given in Table 7 which, at \$2,458,300, compares with \$2,234,000 using the method of estimation outlined above.

As to be expected, additional gross farm revenue per year has increased with the area developed and is likely to continue to increase as the schemes become more fully developed, even though the rate of uptake on both schemes is now slowing.

Table 8

Estimated Additional Gross Farm Revenue
1972/3 - 77/78 ($)

Year	Area of border-dyke irrigation available for stocking on Morven-Glenavy and Lower Waitaki Schemes		Additional stock units[b] (cumulative)	Gross Revenue per stock unit[c]	Additional total gross revenue
	Additional area each year[a]	Cumulative total			
	ha	ha		$	$
1972/73	3,110	3,110	31,100	12	373,200
1973/74	1,720	4,830	48,300	20	966,000
1974/75	2,110	6,940	69,400	11	763,400
1975/76	1,790	8,730	87,300	18	1,571,400
1976/77	980	9,710	97,100	26	2,524,600
1977/78	d	d	d	d	2,458,300[d]
					8,656,900

[a] Additional area of border-dyke irrigation available for stocking in year t is assumed to be the area developed in year t-1.

[b] Additional stock units per hectare assumed to be the difference between stocking rates under irrigation and dryland conditions (16 - 6 = 10 s.u./ha).

[c] Gross revenue per ewe.

[d] Gross revenue for 1977/78 estimated from farm survey data - refer to Table 7.

Source: Farm Surveys (A.E.R.U. and M.A.F.) and Lincoln College Farm Budget Manuals.

A general finding in the survey of farms on the Morven-Glenavy Scheme was that sheep numbers had increased quite dramatically, but that this had occurred partly at the expense of stock performance which, under irrigation, would be expected to improve. As sheep numbers stabilise, performance, in terms of lambing percentage and wool weights, is likely therefore to improve and this will be reflected in further increased output and revenue.

It is estimated that additional gross farm revenue as a result of irrigation has, to date, totalled \$8.7m. Since this additional gross farm revenue accrues, by definition, only to farmers within the two schemes, it is not subject to any direct leakages from the region.

3.4 Total Injections

Total estimated net injections into the Waimate-Waitaki region as a result of the Morven-Glenavy and Lower Waitaki irrigation schemes are shown in Table 9 for the 1977/78 season. Similarly, Table 10 shows the total estimated net injections since construction on the two schemes began in 1970/71. It is important to note that the total injections shown in Table 10 are actual injections, and are not adjusted by any price index to reflect changing values over time.

Having estimated net annual injections, it now becomes necessary to turn to the regional multiplier effects which give an indication of the overall secondary impact that these injections are likely to have on the regional economy.

Alternative methods of estimating regional multiplier effects are examined in the following three chapters.

Table 9

Total Net Injections - 1977/78
Morven-Glenavy and Lower Waitaki Schemes

	Gross Injections	Direct Leakages[a]	Net Injections
	($)	($)	($)
Construction expenditure:			
- off-farm	713,100	266,900	446,200
- on-farm	869,800	217,500	652,300
Operation and maintenance expenditure	72,000	14,400	57,600
Increased agricultural production	2,458,300	0	2,458,300
TOTAL	4,113,200	498,800	3,614,400

[a] Expenditures outside Waimate and Waitaki counties is made up of 20% of operation and maintenance, 25% of on-farm, 50% of the off-farm undertaken by M.W.D., and 25% of the off-farm put out to tender.

Source: Compiled from Tables 3 - 7.

Table 10

Total Injections - 1970/71 - 1977/78

Morven-Glenavy and Lower Waitaki Schemes

Year	Construction Expenditure Off-farm	Construction Expenditure On-farm	Operations and Maintenance Expenditure	Increased Agricultural Production	Total Gross Injections	Direct[a] Leakages	Total Net Injections
	($)	($)	($)	($)	($)	($)	($)
1970/1	377,300)		-	-)			
	)	559,800[b]		)	1,715,400	548,500	1,166,900
1971/2	778,300)		-	-)			
1972/3	1,177,000	412,800	-	373,200	1,963,000	498,450	1,464,550
1973/4	1,231,000	633,000	-	966,000	2,830,000	626,500	2,203,500
1974/5	1,147,400	662,300	8,500	763,400	2,581,600	619,150	1,962,450
1975/6	1,561,200	392,000	29,300	1,571,400	3,553,900	690,535	2,863,365
1976/7	1,096,800	657,000	79,200	2,524,600	4,357,600	588,815	3,768,785
1977/8	713,100	869,800[c]	72,000	2,458,300	4,113,200	495,000	3,618,200
		1,000,000[d]			1,000,000[d]	250,000	750,000
Total Injections	8,082,100	5,186,700	189,000	8,656,900	22,114,700	4,316,950	17,797,750

[a] Expenditures outside Waimate and Waitaki counties. Made up of 20 per cent of O & M. 25 per cent of on-farm, 50 per cent of the off-farm undertaken by the MWD, and 25 per cent of the off-farm put out to contract.

[b] Estimated on-farm expenditure prior to 1972/3.

[c] Includes expenditure on spray irrigation.

[d] Total on-farm expenditure on spray irrigation, 1970/1 - 1976/7.

Source: Compiled from Tables 3 - 9.

CHAPTER 4

EXPORT BASE THEORY - AN OUTPUT MULTIPLIER

Export base theory postulates that all economic activity in a region can be classified as either basic or non-basic. Basic activities earn income for the region through exports[8], whilst non-basic activities recirculate income within the region. This theory adheres closely to the concept that a region's growth and development are dependent on its exports. In fact, the theory has been described as tantamount to regional mercantilism (Wilson, 1968) since a change in total income can only occur with a change in a region's exports.

In its simplest form the model splits total regional income (Y) into domestic income (C) and export income (X). Export income is determined exogenously, with domestic income as a function of regional income.

$$Y = C + X \qquad (1)$$

where $C = cY$

and X is exogenous

$$Y = cY + X \qquad (2)$$

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[8] Exports and imports refer to trade with other regions as well as with other countries

In this model a change in export income will lead, first, to a change in regional income. This change in regional income will then lead to an endogenously determined change in domestic income which, in turn, creates a further, though smaller (assuming $c < 1$), change in regional income, and so on. The total change in regional income is, therefore, a multiple of the regional change in export income. This multiple is identified as the regional multiplier (k). Rearranging equation 2,

$$Y = \frac{1}{1-c} X$$

and,

$$k = \frac{dY}{dX} = \frac{1}{1-c} = \frac{Y}{X} \qquad (3)$$

Thus the export-base multiplier for the region is equivalent to Y/X. This is because exports are the only exogenous or autonomous element in the model, making them the sole component of the multiplicand. Consequently, the average and marginal multipliers are identical, i.e. $Y/X = dY/dX$[9].

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9 In this simple model, Y/X <u>is</u> the multiplier and not, as is sometimes mistakenly believed, a proxy for it.

4.1 Estimation of the Export Base Multiplier

From equation (3) it can be seen that in empirical studies a value for the multiplier can be obtained in two ways; by estimating either $\frac{1}{1-c}$ or $\frac{Y}{X}$. Both approaches pose difficulties, but in export base studies attention is focussed on estimating $\frac{Y}{X}$.

In using $\frac{Y}{X}$ to derive a regional multiplier, it is necessary to know the region's total income or output (Y) and export income (X). As information of this type is not easily accessible, employment data are commonly used as a means of estimating the economic activity within a region[10]. In particular, location quotients are used to estimate a regions's basic or export activity.

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10 Mention should be made about the use of employment data in the estimation of regional multipliers in this and the following two chapters. Invariably, employment statistics are the only data available in any detail at the regional level and it is for this reason that they feature so widely in this and other regional studies. There are obvious disadvantages in using employment as a measure of income or output. Productivity differences within and between industries are likely to affect the level of income in a region, as are salary and wage differentials. However, in the absence of more suitable data, employment is frequently used as an approximate measure of output. There is sometimes the option of collecting primary data through surveys, but too often the cost is prohibitive. Until more suitable data are readily available, employment statistics are likely to remain multi-purpose in use.

In estimating a region's export activity, location quotients can be used firstly to show the degree of local self-sufficiency in various industries. For the purpose of the present study, a location quotient is used to provide, in terms of employment, a measure of the importance of an industry to a region relative to the importance of that industry to the nation[11]. The location quotient for an industry can be calculated as:

$$\text{Location Quotient} = \frac{e_{ij}/\sum\limits_{j} e_{ij}}{\sum\limits_{i} e_{ij}/\sum\limits_{ij} e_{ij}}$$

Where e = employment

i = industry (1, 2, ...n)

j = region (1, 2, ...m).

For example, suppose in a region 2,000 people are employed in the textile industry, and total employment in the region is 10,000. If, at the national level, 500,000 are employed in the textile industry and total national employment is 5,000,000, then the location quotient for the local industry is:

$$\frac{2{,}000/500{,}000}{10{,}000/5{,}000{,}000} = 2$$

11 More generally, "A location quotient is a statistical measure of the degree to which any two quantitative characteristics are dissimilarly distributed between any two areas", Hoover (1975 ; 147).

This shows that the region has exactly twice its pro-rata share of textile workers relative to the national average[12].

Location quotients of greater than 1 can be used to estimate the number of 'surplus' or basic workers in a region, on the assumption that these workers are engaged in production in excess of the region's own requirements and that their output is, therefore, exported. This requires the further assumptions that there is no difference between national and regional consumption patterns and that the nation is a closed economy just satisfying its own needs. In short, the regional economy is assumed to be a miniature of the national economy.

One advantage of using location quotients to estimate export activity is that by estimating the degree of local self-sufficiency in each industry or industrial sector, they take account of indirect exports. Even so, the location quotient technique will generally underestimate the number of basic workers, as some export activity will invariably remain undetected as a result of the aggregation of industries in the employment data. This is because as the employment data become more aggregated, the location quotients tend to unity; that is, self-sufficiency in all industries approaches 100 per cent. Thus, as the data are aggregated, exports in some sectors are balanced by imports in other sectors. It follows

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12 For discussion of location quotients and suggested refinements see Mattila and Thompson, (1955).

that, with the location quotient technique, the greater the aggregation used in industry classification, the fewer the number of basic workers (Terry, 1965).

Location quotients will also tend to underestimate regional exports by failing to account for national exports. For example, a location quotient of 1 means that, given previous assumptions, there are no basic workers in that industry. If, however, the nation exports 50 per cent of this industry's output, then a quotient of 1 for a region implies that half of the workers are engaged in producing for the local market and half for export. An adjustment can be made to take account of national exports if it is felt that the location quotient for an industry will otherwise substantially underestimate the number of basic workers in the region.

Garnick (1969) has suggested that location quotients of greater than one be used to estimate the number of basic workers, thus emphasising imports by making, in effect, all regions net importers. However, this adjustment will reduce the estimate of basic employment and, as has been shown, one of the location quotient technique's shortcomings is that it generally underestimates export activity.

Having calculated location quotients for all industries within a region, it is a simple exercise to find the total number of basic workers. For quotients of greater than 1,

$$S_{ij} = e_{ij} - \frac{\sum_i e_{ij}}{\sum_{ij} e_{ij}} \sum_j e_{ij}$$

where S_{ij} = basic or export workers in industry i, region j.

Total regional employment is then divided by total basic employment to give an estimate of Y/X, the export base multiplier,

$$k = \frac{\sum_i e_{ij}}{\sum_i S_{ij}}$$

Isard and Czamanski (1965) cite several American studies that have used the simple ratio method to derive multipliers ranging from 2.50 to 5.47.

As an alternative to using the ratio of total employment and total basic employment, the multiplier can be estimated by measuring the change in these variables over time,

$$k = \frac{\Delta \sum_i e_{ij}}{\Delta \sum_i S_{ij}}$$

This approach, in effect, introduces an autonomous element into the model and produces a marginal multiplier which is unlikely to equal the average multiplier as, in most instances, the function will not pass through the origin. If time series data are available, total employment can be regressed on export employment, ($Y = a + bX + \mu$, where b is the estimate of the multiplier.) For example, Weiss and Gooding (1968), in a case study of Portsmouth, New Hampshire, dissaggregated export employment into three categories and used time series data to derive, by regression, base multipliers of 1.4 to 1.8.

Export base theory in its simplest form neglects the effects on the multiplier of imports[13] and of production aimed at import substitution but relies on a single relationship, that of export income to total income. The theory can be criticised on account of this single relationship and the high degree of aggregation that it involves, but perhaps a more pertinent criticism is that this relationship is considered constant (see Garnick, 1969) when, in fact, with regional development it can be expected that economic relationships will change. Indeed, this may even be an aim of policy decisions.

A general criticism of the export base multiplier is that since the relative importance of exports to a region is, in general, inversely related to the size of the region, any required value can be obtained for the multiplier by careful selection of the study area. However, this is only

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13 See Richardson, (1970 ; 19-20) for expansion of the simple model to include imports.

to be expected as it is usual for the multiplier to increase as the region is enlarged, since dependence on imports is reduced.

4.2 Application to the Lower Waitaki Area

Export base multipliers for the Lower Waitaki area were estimated using employment statistics and the location quotient approach, since no suitable regional income data were readily available.

4.2.1 The Simple Ratio Multiplier.

The New Zealand Department of Statistics in its quiquennial census of Population and Dwellings for 1971, recorded employment-by-industry on a county and borough basis[14]. Regional employment statistics were detailed for seventy industries (NZSIC Group Level) and these are listed in Appendix 3. Location quotients caluclated from the employment data for Waimate and Waitaki counties and Waimate and Oamaru boroughs are shown in Table 11, along with the estimated number of basic or export workers in those industries where the location quotient exceeds unity.

The data in Table 11 highlight the importance of agriculture and food manufacturing in both counties. Basic employment in Waimate county is, in fact, almost solely confined to these two industries. Separating out Waimate borough, it is seen that agriculture loses significance, whilst

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[14] Similar data were not available from the 1976 Census.

the retail trade, land transport, medical services and a number of other service industries in the tertiary sector all 'export' from the region. The remainder of the county is responsible for the overall importance of agriculture, which accounts for over 80 per cent of export employment when the county is treated as a whole.

Basic employment in Waitaki county is spread over a broader base than in neighbouring Waimate. Agriculture and food and textile manufacturing have significant numbers of export workers, as do the electricity and construction industries (reflecting the importance of hydro-power development on the Waitaki river), the retail trade, hotels and land transport. Viewed in isolation, Oamaru borough, in a similar fashion to Waimate borough, has little employment in agriculture, but more than its pro-rata share in the manufacturing and service sectors. Agriculture, electricity and construction support most of the export employment in the remainder of the county.

The Lower Waitaki area would appear then, by the location quotient technique, to derive its export income largely from agriculture, food manufacturing, electricity and construction, with the two main centres of population, Oamaru and Waimate, specialising more, as one would expect, in the services provided by the tertiary sector.

TABLE 11

LOCATION QUOTIENTS AND BASIC EMPLOYMENT

Industry Number	Waimate County Ex. Waimate Borough		Waimate Borough		Waimate County		Waitaki County Exc. Oamaru Borough		Oamaru Borough		Waitaki County		Waimate and Waitaki Counties Combined	
	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers
1	6.15	959	0.25		4.10	884	3.60	842	0.11		1.62	464	2.30	1348
2	2.31	22	1.56	5	2.05	27	2.74	51	0.31		1.36	24	1.55	51
3	11.40	19	4.07	3	8.85	22	10.64	31	-		4.60	27	5.77	49
4	-		-		-		1.50	5	0.07		.69		0.50	
5	-		-		-		0.29		0.15		.21		0.15	
6	0.23		-		.15		4.05	23	1.39	4	2.54	27	1.88	21
7	-		-		-		0.64		-		.28		0.20	
8													-	
9	0.43		0.40		.42		0.62		1.22	2	.96		0.81	
10	1.48	49	2.20	66	1.73	115	1.19	33	2.47	347	1.92	380	1.86	495
11	-		-		-		-		0.32		.18		0.13	
12	-		-		-		-		-		-		-	
13	0.41		0.52		.45		0.64		4.21	213	2.67	195	2.06	170
14	0.36		1.25	6	.67		0.04		0.16		.11		0.26	
15	-		0.82		.29		0.13		0.29		.22		0.24	
16	0.11		0.21		.15		-		-		-		0.04	
17	0.35		1.08	1	.60		0.31		0.62		.49		0.52	
18	0.41		1.71	4	.86		0.18		0.53		.38		0.51	
19	-		0.11		.04		-		-		-		0.01	
20	0.03		0.61		.23		0.07		0.59		.37		0.33	
21	-		-		-		-		0.19		.11		0.08	
22	0.08		-		.05		0.14		0.43		.31		0.24	
23	-		-		-		-		-		-		-	
24	0.11		-		.07		-		0.19		.11		0.10	
25	-		-		-		-		0.04		.02		0.02	
26	-		-		-		-		-		-		-	
27	-		-		-		-		0.11		.06		0.05	
28	0.40		0.60		.47		0.37		0.91		.68		0.62	
29	-		-		-		1.77	7	3.94	33	3.00	39	2.17	32
30	-		-		-		0.27		-		.12		0.08	
31	0.13		0.06		.31		0.05		0.22		.15		0.14	
32	0.12		0.57		.12		0.24		0.76		.54		0.47	
33	0.05		0.18		.09		0.11		0.27		.20		0.17	
34	0.03		0.06		.04		0.10		0.14		.12		0.10	
35	-		-		-		0.38		1.15	1	.82		0.59	
36	-		-		-		0.08		0.06		.07		0.05	
37	0.05		0.18		.09		3.89	106	1.63	31	2.60	130	1.91	107

Continued/...

TABLE 11 cont.,

LOCATION QUOTIENTS AND BASIC EMPLOYMENT

Industry Number	Waimate County Ex. Waimate Borough		Waimate Borough		Waimate County		Waitaki County Exc. Oamaru Borough		Oamaru Borough		Waitaki County		Waimate and Waitaki Counties Combined	
	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Workers	LQ	Basic Worker	LQ	Basic Workers
38	-		-		-		3.96	8	1.09	0	2.33	9	1.69	6
39	0.45		1.10	9	.68		1.68	191	1.04	16	1.32	207	1.14	127
40	0.28		0.68		.42		0.29		0.99		.69		0.61	
41	0.73		2.74	24	1.43	17	0.73		1.45	27	1.14	15	1.22	32
42	9.41		1.85	86	.91		0.69		1.44	192	1.12	90	1.06	65
43	0.66		1.32	4	.89		0.73		1.41	20	1.12	10	1.05	6
44	0.43		1.78	14	.90		1.75	42	1.68	50	1.71	93	1.49	88
45	0.83		1.76	30	1.15	17	0.99		1.62	104	1.35	102	1.29	120
46	0.09		-		.06		0.20		0.60		.43		0.33	
47	-		-		-		0.28		0.17		.22		0.16	
48	0.48		-		.31		0.14		0.32		.24		0.26	
49	0.44		1.34	9	.75		0.63		1.02	3	.85		0.82	
50	0.43		0.58		.48		0.37		1.02	2	.74		0.67	
51	0.08		0.32		.17		0.17		0.57		.40		0.33	
52	-		0.26		.09		0.08		1.17	3	.70		0.53	
53	0.19		0.75		.39		0.26		0.86		.60		0.54	
54	-		-		-		-		-		-		-	
55	0.20		0.61		.34		0.22		0.52		.39		0.38	
56	0.08		1.58	4	.60		0.44		1.81	22	1.22	10	1.05	3
57	0.62		0.93		.73		0.82		1.05	11	.95		0.89	
58	0.27		-		.17		0.23		0.06		.13		0.14	
59	0.37		1.73	34	.84		0.42		1.48	95	1.02	8	0.97	
60	0.51		1.44	2	.84		3.11	28	1.46	8	2.17	37	1.80	35
61	-		2.70	3	.94		-		0.32		.18		0.39	
62	0.88		0.89		.85		0.89		0.72		.79		0.81	
63	0.12		0.66		.31		0.14		0.31		.23		0.25	
64	0.38		0.72		.50		0.22		0.84		.57		0.55	
65	0.53		2.37	7	1.17	2	0.55		0.88		.73		0.85	
66	0.54		0.75		.61		0.38		1.05	3	.76		0.72	
67	0.14		0.79		.37		0.32		2.27	21	1.43	12	1.14	5
68	1.78	6	1.43	2	1.65	8	1.46	6	1.61	11	1.55	17	1.58	25
69	0.36		1.60	5	.79		0.45		1.50	16	1.05	3	0.98	
70	-		-		-		-		0.34		.19		0.14	
71	0.07		0.10		.12		0.13		0.09		.16		0.33	
Total Basic Workers		1055		318		1092		1373		1235		1906		2785
Total Employment		1922		1027		2949		3336		4394		7730		10,679

Export base multipliers, derived from the ratio of total to basic employment in the region, are shown in Table 12. These multipliers seem large, and those for the counties would appear to be influenced to a considerable extent by the two boroughs which, as shown by the location quotient technique, do not support very much basic employment. Adjustment of the numbers of basic workers to take account of national exports will, however, reduce the size of these simple ratio multipliers. In the agricultural sector, particularly, basic employment is underestimated since some 65 per cent of New Zealand's agricultural output is exported[15]. This, by previous assumptions, means that nearly two-thirds of those employed in agriculture at the national level are engaged in export activity. The effect on the multipliers of adjusting the number of basic workers in agricultural employment by such a factor is also shown in Table 12.

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[15] See New Zealand Year Book 1975, p.383.

Table 12

Simple Ratio Multipliers - 1971

Region	Simple Ratio Multiplier	Adjusted Multiplier[a]
Waimate county (excl. Waimate borough	1.82	1.63
Waimate borough	3.23	-
Waimate county	2.70	2.31
Waitaki county (excl. Oamaru borough)	2.43	2.11
Oamaru borough	3.56	-
Waitaki county	4.06	3.23
Waimate and Waitaki counties combined	3.83	3.09

[a] Adjusted to take account of national agricultural exports.

4.2.2 Use of Time Series Data. It has been stated that, as an alternative to estimating a simple employment ratio the change in total employment in response to a change in export employment can be measured and used as an estimate of the export base multiplier.

Although recording regional employment data in considerable detail, the census, being only a quinquennial undertaking, is of limited value as a source of time series data. The Department of Labour compile employment figures

Table 13

Basic and Total Employment in Waimate and Oamaru Boroughs from 1953 to 1977

Year	Oamaru Borough		Waimate Borough	
	Basic Employment	Total Employment	Basic Employment	Total Employment
1953	599	2938	324	897
1954	742	3208	314	904
1955	697	3170	331	920
1956	718	3182	335	963
1957	768	3393	345	957
1958	825	3499	361	987
1959	874	3640	373	973
1960	901	3692	376	961
1961	931	3727	360	984
1962	924	3759	372	1017
1963	930	3795	370	996
1964	992	3854	380	1005
1965	1020	3982	379	1021
1966	1056	4076	396	1067
1967	1102	4063	401	1032
1968	1027	3814	393	979
1969	1122	3999	381	952
1970	1167	4019	342	963
1971	680	4465	190	936
1972	510	3860	191	918
1973	512	3967	183	909
1974	557	4123	170	944
1975	474	4181	142	897
1976	544	4154	184	977
1977	573	4193	163	930

Source: Analysis of unpublished data from the NZ Dept of Labour annually for employment districts and for towns with a population of over 1,000, although not, unfortunately, for counties. Furthermore, these statistics exclude agriculture and only detail other employment by major industry divisions (12 divisions prior to 1971 and 9 divisions thereafter). However, these data enabled basic and total employment to be estimated over a number of years for the boroughs of Oamaru and Waimate, the two main centres of population in the Waimate-Waitaki region.

It was decided to keep the two classifications of industry divisions separate, and so have two sets of time series data for each borough: from 1953-70 and 1971-77. (The industry classifications are shown in Appendix 4). The location quotient method was again used to estimate the number of basic workers and these are shown, along with total employment, in Table 13.

Although in this instance, concern is with the changes in total and basic employment over time, it is of interest to note that the simple ratio multipliers derived from the Department of Labour data would be considerably larger than those estimated in the previous section owing to the greater aggregation of industry groups as a comparison will show:

	Simple Ratio Multipliers - 1971	
	Oamaru Borough	Waimate Borough
Using Census data -70 industries	3.56	3.23
Using Department of Labour data - 9 industries	6.57	4.93

Using the 1953-70 data in Table 13, total employment was regressed on basic employment for the two boroughs. It was not thought worthwhile to use regression on the seven years of data from 1971 to 1977 and, due to the difference in industry classification, it would not have been feasible to include these data with those for the 1953-70 period. The results of the regression analyses are shown in Table 14.

Taking Oamaru borough first, auto-correlation is clearly evident in equation 1. This is due probably to one or more independent variables being excluded from the model. First differences of the observations are taken in equation 2 to eliminate the trends of both variables over time. In taking first differences the auto-correlation is also eliminated, although the $\bar{R}^2$ is reduced from 0.94 to 0.72.

Since it might be expected that a change in non-basic employment would be a lagged response to a change in basic employment, two regression equations were estimated where basic employment was lagged by one and two years, with total employment again as the dependent variable. Of these, equation 3 is the better in terms of $\bar{R}^2$, t and d values.

Table 14

Regression Equations

Equation Number	Dependent Variable	Intercept	Independent Variables				$\bar{R}^2$	d	n
			X_1	X_2	X_3	X_4			
Oamaru Borough									
1	Y	1733.8	2.11 (0.13)				0.94	0.50	18
2	Δ Y	-3.7		2.01 (0.31)			0.72	2.02	17
3	Y	2018.7			1.88 (0.20)		0.84	1.74	17
4	Y	2136.5				1.81 (0.23)	0.81	1.31	16
Waimate Borough									
1	Y	470.8	1.39 (0.25)				0.65	1.37	18
2	Δ Y	3.4		0.46 (0.48)			0.00	1.80	17
3	Y	654.3			0.90 (0.33)		0.29	0.93	17
4	Y	793.0				0.53 (0.34)	0.09	0.82	16

Y = Total Employment in region (proxy for total income).

X_1 = Basic or Export Employment in region (proxy for export income).

X_2 = X_1 (First Difference of Variables).

X_3 = Basic Employment Lagged by One Year

X_4 = Basic Employment Lagged by Two Years

$\bar{R}^2$ = Coefficient of Multiple Determination adjusted for degrees of freedom.

d = Durban-Watson statistic

n = Number of Observations

Values in brackets are standard errors.

The most likely estimate of a multiplier for Oamaru borough would, therefore, seem to be around 1.9 - 2.0.

If the employment data for Oamaru borough were thought to be a reasonable fit for the regression models, the same cannot be said of the data for Waimate borough. Of the four equations only the first, with an estimate for the multiplier of 1.39 and an $\bar{R}^2$ of 0.65, explains a reasonable amount of the variation in total employment. In the second equation where, as with the data from Oamaru borough, first differences were taken to eliminate any time trends, the $\bar{R}^2$ is reduced to zero. Although this would suggest that basic employment does not explain movements in total employment on a year to year basis, an indication of the general relationship between basic and total employment over time may still be given by the first equation.

Rather than relying on simple linear regression to estimate the relationship between total and basic employment, multiple regression can be used to include other variables (see McCamley, 1971). However, it was decided, for the purpose of the present study, not to further refine the export-base model.

CHAPTER 5

A KEYNESIAN INCOME MULTIPLIER

A second method of estimating a regional multiplier is to use a simple Keynesian income determination model at the regional level:

$$Y = C + I + G + X - M$$

$$C = a + c(Y - T)$$

$$M = b + mY$$

$$T = e + tY$$

where,

Y = regional income

C = regional consumption expenditure

I = investment within region

G = Government expenditure in the region

X = regional exports

M = regional imports

T = direct taxation

c = marginal propensity to consume

m = marginal propensity to import

t = marginal rate of direct taxation

a, b, e are constants

From this model the regional multiplier, k, is,

$$k = \frac{1}{1 - (c-m) \quad (1-t)}$$

In some ways this model can be seen as an expansion of the export base model, although the inclusion of exogenous and autonomous elements, other than exports, precludes the estimation of the multiplier as a simple ratio between total income and export income.

The multiplier effects in this model are a function of the marginal prospensity to consume (c), the marginal propensity to import (m) and the marginal rate of direct taxation (t), all of which 'leak' income from the region. A value for the multiplier can, therefore, be obtained by estimating c, m and t. In dealing with local multiplier effects these estimates should obviously pertain to the region rather than to the nation. However, lack of data makes estimation of the marginal propensity to consume at the regional level impossible without resorting to the collection of primary data, and a national value for c, therefore, has to be used in the model. Data on regional trade are non-existent and the estimate of the marginal propensity to import can be no more than an approximation. Nevertheless, a knowledge of regional imports is essential if local multiplier effects are to be estimated from this model and one method by which an approximate value for m can be obtained is outlined in the following section. A value for t can be estimated from income and tax statistics.

5.1 A Method of Estimating the Marginal Propensity to Import

A value for m is obtained indirectly by estimating the proportion of consumption expenditure that contributes to local income; that is (c-m). To estimate this regional income component it is necessary to establish, firstly, the extent to which local production[16] can supply the goods and services required to satisfy regional consumer demand, and secondly, the proportion of the consumer expenditure on these locally produced goods and services that is retained within the region.

In dealing with the former, Archibald (1967), in a study of regional multipliers in the UK, assigned the various categories of consumer expenditure to either imports or local production. Being primarily concerned with estimating a minimum value for the multiplier, he assumed that local production was confined solely to the distributive and service industries, with all primary and manufactured goods having to be imported. McColl and Throsby (1971), in estimating a multiplier for a "typical" Australian region, were less sweeping and split each category of consumer expenditure into import and local production components, but still did so on a fairly arbitrary basis. In the present study, to determine those goods and services that are produced in the region, it would seem

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[16] Production here refers to the service sectors as well as primary and manufacturing sectors.

logical to again make use of regional employment data and location quotients. Location quotients will give an indication of the extent to which consumer demand for the goods and services of various sectors is likely to be met by local production, assuming, of course, that regional and national patterns of consumption expenditure are alike[17]. For those industries with location quotients of less than one it can be assumed that imports will be required to satisfy regional consumer demand.

Having established the proportion of consumption expenditure that is spent on locally produced goods and services, it is then necessary to estimate how much of this expenditure contributes to regional income. Archibald used direct labour costs as a measure of Local Value Added, while McColl and Throsby preferred to use Wages, Salaries and Gross Operating Surplus measuring, in effect, the return to management as well as labour.

For the purpose of the present study it was decided to adopt the latter and assume that of local production costs, only the factor payments to labour and management will be retained within the region. It is thereby assumed that all other payments, including those for the purchase of intermediate inputs, accrue as income only to persons

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17 See pp 39-41 for further assumptions pertaining to location quotients.

outside the region[18]. This approximation procedure is unavoidably crude and may either under or over estimate the local income component. For example, the purchase of any locally produced intermediate inputs will increase the proportion of consumption expenditure retained within the region, whilst persons working in the region but living elsewhere will have the effect of reducing the local income component.

Consumer expenditure and the factor payments made to labour and management can both be estimated in an approximate fashion from the Inter-Industry (Input-Output) Study of the N.Z. economy. Consumption expenditure by industry is listed in the Household Consumption column of Final Demand, and payments to labour and management, for the same industries, are shown in the Wages and Salaries and Operation Surplus[19] rows in the Primary Inputs quadrant.

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[18] By estimating (c-m) in this way indirect taxation on consumption, being a part of the expenditure 'leaked' from the region, is implicitly accounted for in m, although McColl and Throsby include an estimate of indirect taxation along with their estimate of t, the marginal rate of direct taxation. As an added leakage of income from the region this will reduce any estimate of the multiplier.

[19] Although primarily the reward for entrepreneurship, the Operating Surplus in the N.Z. Input-Output tables also includes the return on capital and will, therefore, over-estimate the return to management. Interest payments will, however, contribute to regional income if capital is locally owned.

Expressed as a percentage of total inputs, the latter can be used to estimate the proportion of consumption expenditure that accrues to labour and management as income. Combining this with the location quotient technique of identifying that part of consumption expenditure which is spent on locally produced goods and services, it is possible to make an estimate of the contribution to regional income.

For example, suppose a particular industry in the region has a location quotient of 0.6. If consumption expenditure on the output of that industry is $10m, it is, therefore, assumed that $6m can be supplied from local production. If it is further supposed that factor payments to labour and management in this industry account for 50 per cent of total inputs then,of this $6m, $3m is retained locally and contributes to regional income. Of the remaining $7m of the original consumption expenditure, $4m is leaked from the region through direct importation of the good or service and $3m is leaked through the importation of inputs needed by the local industry.

The local income component of consumption expenditure in a particular industry is, therefore, the payments to labour and management as a proportion of total inputs multiplied by the location quotient for the industry (where the location quotient is less than 1) multiplied by the actual consumption expenditure in that industry. The resulting estimates of locally retained expenditure can be summed and expressed as a percentage of total consumption expenditure. With a value for c, this local income component can then be expressed in terms of c-m.

McColl and Throsby estimated that a minimum of 29 per cent of consumption expenditure would be retained locally. With a value of c = 0.9, c-m was, therefore, approximately 0.25. This meant that the marginal propensity to import, m, was 71 per cent of consumption expenditure or about 65 per cent of disposable income. With t values ranging from 0.15 - 0.35, they estimated the regional multiplier to be 1.19 - 1.27. Archibald was able to regress Local Value Added on disposable income over a number of years and in so doing estimated a minimum value for c-m of 0.23. Combining this with values for t of 0.18 - 0.30, he estimated the regional multiplier to be not less than 1.2.

5.2 Application to the Lower Waitaki Area

5.2.1 A Value for c-m Applying the procedure outlined in the first part of this chapter to the Lower Waitaki area, locally retained income was estimated to be 0.38 for consumption expenditure with the marginal propensity to import, m, accounting for the remaining 0.62.

This estimate of locally retained income was obtained using the Department Statistics Inter-Industry Study of the New Zealand economy for 1971-72 and employment data for Waimate and Waitaki counties from the 1971 Census of

Population and Dwellings. Location quotients for the twelve industry groups of the Inter-Industry study[20] were calculated from the employment data (see Appendix 6), and as an approximate measure of the extent to which local production can satisfy local consumer demand, these location quotients appear in column 1 of Table 15.

Wages, salaries and operating surplus as a percentage of total inputs for each of the twelve industry groups, representing the return to labour and management, are shown in column 2 of Table 15. Consumption expenditure by industry, as shown in the Household Consumption column of the Final Demand sector of the Inter-Industry study, is shown in column 4 of the same table. From these data the proportion of local consumption expenditure retained within the region as income was estimated to be 0.38. Calculated separately for Waimate and Waitaki counties, this income component was estimated at 0.31 and 0.40 respectively. The greater self-sufficienty of Waitaki county, as reflected in its lower marginal propensity to import, would seem largely a result of the economic and business activity in Oamaru.

5.2.2 <u>A Value for t</u> An approximate value of t for the Lower Waitaki area was estimated at 0.20 by taking an average of the marginal rates of taxation over all income

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20 It was felt that a greater breakdown of the economy and use of the Inter-Industry studies for 25 and 130 industries would not produce a more accurate estimate for c-m. See Appendix 5 for a list of the twelve industry groups.

Table 15

Estimation of Locally Retained Expenditure

Industry Group	(1) Location Quotients[a]	(2) Wages & Salaries and Operating Surplus as a proportion of total inputs.	(3) Proportion of Consumption Exp. retained locally (1) x (2)	(4) Consumption Expenditure ($)	(5) Consumption Expenditure retained locally (3) x (4) ($)
1	> 1.0	0.49	0.49	97.0	47.53
2	0.33	0.62	0.20	0	0
3	0.50	0.41	0.21	3.0	0.63
4	> 1.0	0.20	0.20	427.6	85.5
5	0.41	0.37	0.15	802.4	120.36
6	> 1.0	0.45	0.45	72.4	32.58
7	> 1.0	0.32	0.32	0.7	0.22
8	> 1.0	0.57	0.57	1115.6	635.89
9	0.86	0.53	0.46	174.9	80.45
10	0.53	0.61	0.32	604.9	193.57
11	0.46	0.64	0.29	4.1	1.19
12	0.90	0.65	0.59	320.1	188.8
				3622.7	1386.72

Proportion of consumer expenditure retained locally:

$$\frac{1387}{3623} = 0.38$$

Source: Inter-industry study of NZ Economy 1971-72, Department of Statistics.
Census of population and dwellings 1971, Department of Statistics.

[a] See Appendix 6

groups weighted by the number of persons in each group. It could be argued that a rate of marginal taxation pertaining to certain sectors or income groups within the region should more appropriately be used as an estimate of t. The direct income effects of the initial investment in irrigation can be easily singled out as accruing to those employed in agriculture and the construction industry. However, the subsequent rounds of income generated by increased spending in the region cannot be allocated to specific industries or income groups so easily. Furthermore, Archibald found that the multiplier was not particularly sensitive to alternative values of t and this is confirmed by the results shown in Table 16. It was decided, therefore, to use a marginal rate of taxation for the region rather than one that was specific to, say, incomes in agriculture and the construction industry.

5.2.3 A Value for c As mentioned at the beginning of this chapter, lack of data on regional consumption patterns means that a national value for the marginal propensity to consume (c) has to be used. Deane and Giles (1972) have tested various consumption equations for New Zealand, regressing consumption on Permanent Income and a number of other explanatory variables. Concentrating on Permanent Income as the major explanatory variable, they estimated a total marginal propensity to consume of between 0.7 and 0.8. Long run marginal propensities to consume out of Current Income were estimated at 0.8[21] and 0.08 for non-durables and durables respectively.

Since the models of Deane and Giles omit expenditures on services and automobile sales owing to a lack of suitable data, a value for c of 0.9 was thought appropriate for use in the present study.

5.2.4 <u>An Estimate of the Multipliers</u> With c = 0.9, the locally retained income component for the area becomes 0.34 of disposable income. Combining this with the value for t, we can estimate the regional multiplier (k) to be:

$$k = \frac{1}{1-(0.34\ (0-0.2)} = 1.37$$

For Waimate County, with c-m = 0.28, the multiplier becomes:

$$k = \frac{1}{1-(0.28)\ (1-0.2)} = 1.29$$

and for Waitaki county, with c-m = 0.36,

$$k = \frac{1}{1-(0.36)\ (1-0.2)} = 1.40$$

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21 This is a weighted average of the marginal propensity to consume non-durables out of salary and wage income of 0.91 and the marginal propensity to consume non-durables out of 'other' income of 0.38. The weightings of 0.8 and 0.2 respectively are those referred to by the authors (Deane and Giles, 1972 : 18).

Table 16 shows the sensitivity of the three multipliers over a range of t values.

Table 16

Sensitivity of the Multiplier to Alternative t Values

c-m	t =0.15	0.20	0.25	0.30
0.28	1.31	1.29	1.27	1.24
0.34	1.41	1.37	1.34	1.31
0.36	1.44	1.40	1.37	1.34

The most likely estimate of a multiplier for the Waimate-Waitaki region, using this Keynesian model approach, would be 1.3 - 1.4.

One limitation of the aggregate multipliers of the export base and Keynesian models is that they reveal little, if anything, about the differing impacts of investments in different sectors of the economy. The following chapter examines input-output modelling which, in contrast, enables the estimation of sectoral multipliers.

CHAPTER 6

MULTIPLIERS FROM INPUT-OUTPUT ANALYSIS

The most comprenehsive approach to estimating multiplier effects involves the construction of an Input-Output model. This enables the estimation of output, income and employment multipliers for individual sectors within an economy. However, the vast amount of data required for the analysis means that the cost in man hours, or what is more likely to be man years, precludes for most regional studies (including the present study) the building of an input-output (I-O) model from survey-based data.

As a compromise some researchers have sought to achieve 'rough and ready' I-O tables for regions by making adjustments to a national table based on readily available secondary data (usually regional employment). These 'non-survey' approaches to I-O modelling have attracted both interest and criticism. As short cut measures in obtaining regional tables they are far less costly than survey based studies, but this saving is made at the expense of accuracy.

An example of the way in which one of these non-survey techniques can be applied at the regional level will be explained later in this chapter after a more general treatise of I-O modelling.

6.1 Input-Output Modelling[22]

In an attempt to establish the interactions between all sectors of an economy, it is necessary to think in terms of a general equilibrium model, where the effects on an exogenous change in any one sector can be traced through the entire economy. I-O modelling is a method of representing these interactions.

I-O analysis is generally associated with the name of Leontief who, in the 1930's, represented empirically the concept of economic interdependence in an I-O model of the American economy. Since then, I-O analysis has become an accepted method by which to study the interdependencies within an economy, usually at the national level.

Inter-industry relationships within an economy are represented in the I-O table by the Transactions Matrix. This is constructed by first assigning a row and a column to each industry[23]. All inter-industry transactions are then inserted in their respective cells. Since one industry's output is frequently another industry's input, the inter-dependence of industries is built into the matrix on this 'from-to' basis.

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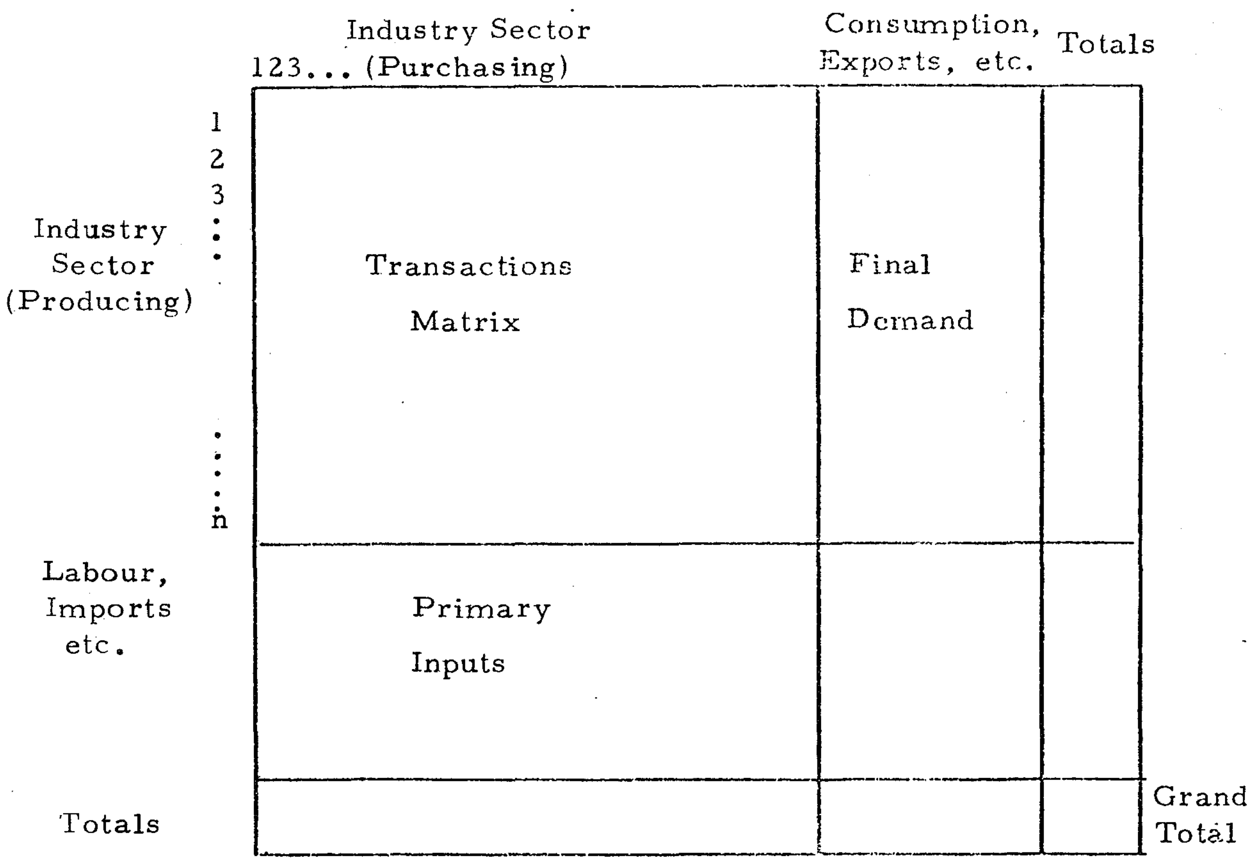
22 For a comprehensive treatise on input-output modelling see Chenery and Clark (1962).

23 Dividing an economy into industries, or more correctly, industrial sectors, involves, even in large I-O models, a considerable degree of aggregation. Consequently, each 'industry' comprises several to many industries.

That part of an industry's output not used by another industry as an input (e.g. exports, household consumption) passes into Final Demand. Similarly, those inputs that are not the output of another industry (e.g. imports, labour) are treated as Primary Inputs. The Transactions Matrix and Final Demand and Primary Inputs quadrants are represented in Figure 4.

Figure 4

<u>Representation of an Input-Output Table</u>



The fourth and remaining quadrant in the I-O table accounts for direct transactions between Primary Inputs and Final Demand.

The completed I-O table shows the source of each industry's inputs (reading down the columns) and the destination of each industry's output (reading across the rows). Row and column totals for each industry will be equal since total inputs must sum to total outputs.

The output of each of the n sectors can be shown as,

$$X_i = (X_{i1} + X_{i2} \ldots . + Z_{in}) + D_i \qquad i = 1,2 \ldots n \quad (1)$$

where X_i = total output of sector i

X_{ij} = output of sector i used as an input by sector j, j = 1,2...n

D_i = output of sector i passing into Final Demand

or $$X_i = \sum_{j=1}^{n} X_{ij} + D_i \qquad i = 1,2 \ldots n \quad (2)$$

X_{ij} as an input into sector j can be expressed as a proportion of that sector's total inputs.

$$X_{ij} = a_{ij} X_j$$

or $$a_{ij} = X_{ij}/X_j$$

Equation (2) can then be rewritten as,

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + D_i \qquad i = 1,2 \ldots n \quad (3)$$

In matrix notation, for all n sectors;

$$X = AX + D \tag{4}$$

$$\text{where } X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} ; \; A = \begin{bmatrix} a_{11} \cdots a_{1n} \\ \vdots \quad\quad \vdots \\ a_{n1} \cdots a_{nn} \end{bmatrix} ; \; D = \begin{bmatrix} D_1 \\ D_2 \\ \vdots \\ D_n \end{bmatrix}$$

The A matrix is the Transactions Matrix expressed in the form of coefficients and its a_{ij} elements are the 'technical' or 'input-output' coefficients and are treated as constants.

6.1.1 Multipliers

Rearranging (4) we have;

$X - AX = D$

$(I - A)X = D$

$X = (I-A)^{-1}D$

where (I-A) is termed the Leontief Matrix.

As far as the present study is concerned, I-O modelling is of particular interest in that output, income and employment multipliers can be easily derived for each sector using the inverse of the Leontief (I-A) matrix.

The elements, r_{ij}, of the $(I-A)^{-1}$ matrix show the direct and indirect output required from industries in response to a unit increase in Final Demand. A simple Output Multiplier (direct and indirect output) can be obtained for each sector by summing the columns of the inverted Leontief matrix.

$$\text{Simple Output Multiplier for sector } j = \sum_i r_{ij}$$

where r_{ij} = the direct and indirect requirement needed from sector i for a unit increase in the Final Demand of sector j.

The direct effect on income from an increase in the output of a sector is simply the payments to households, as shown in the Primary Inputs quadrant, expressed as a porportion of sector output, i.e. shown as a coefficient.

$$w_j = H_j / x_j$$

where w_j = payments to households per \$1 of output in sector j

H_j = payments to households in sector j

The direct and indirect income resulting from an increase in the Final Demand of a sector can be estimated as,

$$y_j = \sum_i r_{ij} w_i$$

where y_j = direct and indirect income generated from a \$1 increase in the Final Demand of sector j.

w_i = the appropriate element in the column vector of payments to households per \$1 of sector output.

As such, y_j is the direct and indirect income multiplier for the sector given an increase in sales to Final Demand. Dividing this by the direct income effect, w_j, enables the estimation of the Type 1 income multiplier, which shows the direct and indirect income generated given an increase in direct income.

$$k1_j = \sum_i r_{ij} w_i / w_j$$

where $k1_j$ = the Type 1 income multiplier for sector j.

The Simple Output Multiplier and the Type 1 Income Multiplier embody only the indirect effect generated by a change in direct output or income. To derive multipliers that include the induced effect, initiated by consumer spending, the household row and column, formerly in the Primary Inputs and Final Demand quadrants respectively, must first be moved into the Transactions Matrix. This, effectively, treats households as an industrial sector. As such, payments to households (as shown in the households' row) and consumer purchases (as shown in the households' column) become linear functions of sector output and household income respectively. This means that the household income generated as a result of the direct and indirect effects induces further increases in output and income through consumer spending. Direct, indirect and induced effects can be derived from the inverse of the (I-A*) matrix, where A* is the A matrix enlarged to n+1 to include households.

Summing the columns of the $(I-A^*)^{-1}$ matrix over the n non-household sectors gives an estimate of the Total Output Multiplier (direct, indirect and induced output).

$$\text{Total Output Multiplier for sector } j = \sum_{i=1}^{n} r_{ij}^{*}$$

where r_{ij}^{*} = the elements of the $(I-A^*)^{-1}$ matrix

The elements in the households' row of the inverted matrix represent the direct, indirect and induced <u>income</u> accruing to households as a result of a $1 increase in the respective sector's output.

$$Y_j = r_{Hj}^*$$

where

Y_j = the direct, indirect and induced income generated from a $1 increase in the Final Demand of sector j.

$r_{Hj}*$ = the appropriate element in the households' row of the $(I-A^*)^{-1}$ matrix.

These households row elements also represent the direct, indirect and induced income multipliers, given a change in sales to Final Demand. The direct, indirect and induced income can also be expressed in terms of a Type 2 multiplier where, as with the Type 1 multiplier, the total increase in income is divided by the direct income effect.

$$k2_j = r_{Hj} *$$

where

$k2_j$ = the Type 2 income multiplier for sector j.

Employment multipliers can be caluclated in a similar fashion to income multipliers, but using a vector of employment/output coefficients in place of payments to households, w_i.

6.1.2 Limitations. I-O modelling suffers from limitations of both a practical and theoretical nature. The former relate primarily to the data requirement which invariably entails extensive and detailed survey work. That completed tables are usually published severalyears in arrears of the year to which they refer gives an indication of the enormity of the undertaking[24]. Furthermore, in addition to being historical in nature, the analysis only relates to a single year.

On the theoretical side, I-O analysis is subject to the assumption of linearity in that the inputs used by any industry vary in direct proportion to that industry's output - i.e., the a_{ij} elements in the A matrix are constant - thus precluding economies of scale and input substitution[25].

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[24] The 1971-72 tables for the New Zealand economy were released in 1978.

[25] The three main assumptions that underlie I-O analysis are (i) homogeneity, (ii) proportionality and (iii) additivity. See Chenery, and Clark (1962, 33-42).

6.2 A Non-Survey Technique for Deriving a Regional Input-Output Table

The main advantage of non-survey approaches to regional I-O modelling lies in their low cost as compared with survey based studies which rely heavily on the collection of primary data. In contrast, non-survey techniques make use of a national I-O table and readily available secondary data. Regional tables derived in this way, being only approximations, are less accurate than their survey based counterparts[26], but should embody the main characteristics of the local economy and, as such, have attracted growing interst in recent years from regional economists (see Schaffer and Chu (1969), Morrison and Smith (1974), Boisvert and Bills (1976) and Jensen et al (1977).

The Transactions Matrix of the regional I-O table contains all transactions between those industries located in the region, and is of particular interest in the present study since it is these inter-industry relationships that give rise to the regional multiplier effects. It has been said that generally a region can be expected to be more dependent than the nation on imports, and that this greater dependence on imports from 'the rest of the world' causes the multiplier effects for the region to be lower than those for the nation. In the A matrix of the regional table, this

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[26] For an evaluation of non-survey techniques see Butterfield and Mules (1977).

greater dependence on imports is reflected in smaller inter-industry coefficients, i.e. smaller a_{ij} coefficients. The non-survey technique, therefore, is primarily a procedure for reducing the a_{ij} coefficients of the national table so that they more closely represent inter-industry transactions at the regional level. Adjustments to the national table to this end are based largely on the relative intensities of regional employment.

The actual procedure adopted in the present study will be along similar lines to a non-survey technique of Generating Regional Input-Output Tables (GRIT) developed at the University of Queensland (Jensen et al., 1977). GRIT takes the form of a fifteen step sequence, the main elements of which are embodied in the remaining part of this chapter.

GRIT is largely concerned with making adjustments to the coefficients of the Transactions Matrix and Primary Inputs quadrant of the national I-O table. It is assumed that, for each industry, the nation and the region have the same input mix and that, therefore, the a_{ij} coefficients in the regional A matrix will differ from those in the national table only as a result of the region's greater propensity to import. Thus, the procedure concentrates on a means of splitting each a_{ij} coefficient into two parts; that which represents regional production and that which has to be imported. The former remains in the A matrix, while the latter is transferred to the imports row of the Primary Inputs quadrant.

The simple location quotient approach is used in the present study as a means of estimating this breakdown between regional production and imports[27]. In the absence of more suitable data this approach is forced to rely on regional employment statistics. Firstly, if employment data indicate that a particular industry does not exist in the region then that industry's row coefficients are transferred in full to the imports row, leaving a row of zeros in the A matrix. This, effectively, accounts for non-competitive imports, i.e. imports with which the region cannot compete.

Secondly, location quotients (LQ)[28] are used to estimate competitive imports. It is assumed that for those industries with less than their pro-rata share of output[29] imports will be required to supplement their inter-industry sales. These inter-industry sales, as represented in the a_{ij} coefficients in the A matrix of the national table, therefore need to be scaled down in the regional table. This is done by simply multiplying the row coefficients of each industry by that industry's LQ where LQ<1. At the same time the residual quantities, i.e. $a_{ij} - (a_{ij} \times LQ_i)$, are transferred

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27 For other approaches in reducing the a_{ij} coefficients of the national A matrix, see Schaffer and Chu (1969).

28 For the definition of location quotients, see p. 39-41.

29 With the location quotients employment has to be used as a proxy for output.

to the imports row of the Primary Inputs quadrant. For those industries with an LQ of greater than one the row coefficients in the A matrix are left unaltered since regional production is assumed to be sufficient to meet local inter-industry sales.

It should be remembered here that, for each sector, the underlying input structure (as shown by the column a_{ij} coefficients) is assumed to be the same at the regional level as at the national level. However, at the regional level more of a sector's inputs will be supplied through regional imports and less through local inter-industry sales. Therefore, each coefficient in the regional A matrix will lie somewhere between its value in the national A matrix and zero, depending on the LQs of those sectors supplying the inputs.

The adjustment procedure has, so far, been purely mechanical in nature. A special feature of the GRIT methodology is the use of "superior" data where appropriate. This means that, although the same mechanical procedure is followed, the analyst has the opportunity to insert data whenever it is felt that these are of superior quality. For example, if there were primary data to suggest that a coefficient in the table was substantially over or under-estimated, then the coefficient could be altered if it was felt that this would significantly improve the model.

Having established coefficients for the A matrix and Primary Inputs quadrant of the regional I-O table, these coefficients then need to be reconverted to dollar transactions and estimates made of the Final Demand quadrant. The former is achieved by multiplying the column coefficients by the total value of output for each sector, a reverse of the procedure used to derive the a_{ij} coefficients. Total regional output for each sector, if unknown, therefore needs to be estimated from secondary data or apportioned from national output on a pro-rata basis.

The amount of each industry's output passing into Final Demand can then be estimated as the residual remaining after inter-industry sales are subtracted from total output. However, there still remains the problem of disaggregating this Final Demand component. Using GRIT the number of Final Demand categories is restricted to three: Household Consumption, Exports and Other (i.e. Government, Stock Change, Capital Formation, etc.)

The Household Consumption and Other Final Demand columns, like regional output in each of the sectors, may need to be estimated as a direct proportion of the national column if no superior data are available. After the Household Consumption and Other Categories of Final Demand have been established the Export column can be derived as the residual.

The modified I-O table can now be used to derive sectoral output, income and employment multipliers for the region as explained earlier in this chapter.

6.3 An Input-Output Table for Otago

It was decided for the purpose of the present study to derive a regional I-O table for the Otago Statistical Area. This would allow the use of more detailed secondary data unavailable at the county level. The choice of Otago, however, was not an obvious one since the Waitaki river, as well as being the county boundary, divides the study area between the Otago and Canterbury Statistical Areas. Even though Waimate county, to the north of the river, is in the Canterbury Statistical Area, it was felt that a table for Otago would be preferable since Oamaru, in Waitaki, is the main business centre within the study area (refer to Figures 2 and 3).

The Department of Statistics' 25 sector I-O table of the New Zealand economy for 1971-72 was used as the basis from which regional adjustments were made (The sector classification is listed in Appendix 7.) In the New Zealand tables all transactions are shown in the basic values, intra-sectoral transactions are presented in gross form and all imports are allocated directly. Updating of the 1971-72 table was not carried out although this could be undertaken as an exercise at a later date. No attempt either was made to 'close' the national table with respect to imports. The adjustment, when undertaken, allocates competitive imports over those domestic sectors that most likely would have produced them had they not been imported. The underlying premise is that there is no reason to suppose a region's imports from other countries will reflect the same pattern as national imports. However, an allocation of national imports over the domestic sectors can only be carried out in an arbitrary manner and in the present study it was decided to retain national imports in the imports row of the Primary Inputs quadrant and thus assume that Otago's imports from other countries do, in fact, reflect the same pattern as national imports.

Before estimating competitive imports, use was made of the 130 sector table to estimate some of the non-competitive imports of the region. The absence of sufficiently detailed employment data from the Census of Population and Dwellings prevented the use of the 130 sector table as the basis for all adjustments. However, the Census of Industrial Production records regional employment in the 86 manufacturing sectors of the 130 sector table and these data were used to estimate non-competitive imports in the manufacturing sectors. For the Otago region zero employment occurs in 10 of the 86 manufacturing sectors and so the row coefficients of these 10 sectors were transferred in full to the imports row in the Primary Inputs quadrant. Since the lack of similar data precluded the estimation of non-competitive imports in the remaining 44 non-manufacturing sectors of the 130 sector table, total non-competitive imports for the Otago region are likely to be understated. Zero employment in any of the sectors is, of course, unidentifiable in the 25 sector table owing to the degree of aggregation.

Competitive imports were then estimated for the 25 sector table using location quitients with employment-by-industry data from the 1971 Census of Population and Dwellings (see Appendix 8).

Salary and wage payments and total gross output for each of the nine manufacturing sectors of the 25 sector table were obtained from the Census of Industrial Production for 1971-72. As a proportion of output the salary and wage payments can be used as 'superior data' to replace the national coefficients in the Compensation of Employees row of the Primary Inputs quadrant. If the salaries and wages coefficient for a sector is different from that in the national table, then the column coefficients of that sector will no longer sum to unity as they should. To correct for this all of the sector's remaining column coefficients in the A matrix and Primary Inputs quadrant are scaled either up or down, depending on whether the 'superior' coefficient is less or greater than the coefficient that it replaces, so that the column coefficients still sum to unity. Of the nine 'superior' salary and wage coefficients for Otago, seven were slightly larger than those in the national table and two slightly smaller.

The gross output totals for the nine manufacturing sectors were used to reconvert the column coefficients to dollar transactions. All other sector output totals had to be estimated from the national table on an employment pro-rata basis.

Of sales to Final Demand, which, in the regional table, are assumed to be the difference between total inter-industry sales and gross output for each sector, the Household Consumption and Other columns were estimated as a direct proportion of the national column on a per capita and an employment basis respectively.

Having estimated the Household Consumption and Other Final Demand columns for the Otago table, nine sectors exhibited a negative value in the exports column. That is, for each of these nine sectors the estimated Household Consumption and Other Final Demand exceeded the difference between total gross output and intermediate sales, yielding a negative residual. For seven of these sectors (7, 9-12, 19 and 22) this is likely to be the result of the location quotients being too large. In using the location quotient approach to estimate regional production, it will be remembered that employment had to be used as a proxy for output. If the estimated output of the seven manufacturing sectors is compared with their actual output as shown in the Census of Industrial Production (and used as superior data), it is evident that for all seven sectors, the location quotient approach has overstated the value of gross output. Therefore, in these seven sectors, intermediate sales and Other Final Demand were scaled down to eliminate the negative residual in the exports column.

To make exports equal to zero in the remaining two sectors (13 and 20) adjustments were made to the Household Consumption category of Final Demand. This was because intermediate sales and Other Final Demand were either zero or of insufficient size to accommodate the adjustments.

In scaling down these row transactions, all residual amounts are transferred to the appropriate cell in the imports row of the Primary Inputs quadrant so that the columns still sum to the gross output (i.e., existing column totals) which have remained unaltered throughout the scaling procedures.

With the adjustment procedure completed the Transactions Matrix for Otago was used as a basis from which to estimate sectoral multipliers. The 'A' matrix of a_{ij} coefficients is shown in Table 17. To close the table with respect to households, the Compensation of Employees row and the Household Consumption column, previously in the Primary Input and Final Demand quadrants respectively, were brought into the Transactions Matrix. As an endogenous sector, the sum of the Household column must equal the sum of the Household row and to meet this requirement it was necessary to scale down the Household Consumption column slightly. This was chosen in preference to scaling up the Compensation of Employees row since the latter contains a greater amount of superior data.

The Simple Output Multiplier and income multipliers from the 'open' table, incorporating the indirect effect, are presented in Table 18. The Total Output Multipler and income multipliers from the 'closed' table, incorporating the indirect and induced effects, are shown in Table 19.

In calculating the employment multipliers an employment vector was estimated by measuring, for each sector, the change in employment over the period 1971/72 - 1976/77 per $1 increase in real gross output over the same period. This should be more indicative of changes in employment at the margin than would be the average employment-output ratio expressing total employment as a proportion of total output. As such, the employment vector provides a contrast to the household income vector which is, of course, an estimate of the average change in income per change in output. This is an important point to bear in mind when interpreting the total income and employment effects per $1 increase in Final Demand.

The estimation of the employment vector is shown in Table 20. Changes in employment over the period were estimated from the Census of Population and Dwellings and the Department of Labour's survey data. Changes in gross output were estimated from the Department of Statistics' inter-industry studies of the New Zealand economy. These were then deflated by the consumer "All Group" price index so that changes in gross output were expressed in 1971 prices. A vector of indirect employment was then obtained through straight forward division of the change in employment by the change in real gross output. The vector is shown, in terms of a $1m increase in real gross output, in columns 4 of Table 20.

This employment vector was then used to derive employment multipliers and these are shown in Table 21.

TABLE 17 - Coefficients of the Transactions Matrix for Otago

	1	2	3	4	5	6	7	8	9
1	0.1731	.4484E-02	.1471E-02	0.	0.4675	.2871E-01	.4117E-02	0.	.5115E-03
2	0.	.4484E-02	0.	0.	.4353E-02	.2208E-03	0.	0.	0.
3	0.	0.	.9169E-01	0.	0.	0.	0.1020	0.	0.
4	.6881E-03	0.	.1074E-02	.5223E-01	.1658E-02	.6448E-03	.2732E-03	.3114E-03	.7841E-02
5	.7903E-02	.1345E-01	0.	0.	.5502E-01	.1126E-01	.3743E-03	.8532E-03	.9718E-02
6	.5365E-02	0.	.7353E-03	0.	.2271E-02	0.1972	.3369E-02	.1280E-02	.2813E-02
7	.3206E-02	.6918E-02	.7562E-03	.2508E-02	.1233E-02	.1022E-02	.7891E-01	.4387E-03	.9206E-03
8	.2726E-02	0.	.6912E-03	.1528E-02	.1293E-01	.9756E-02	.4574E-02	.2406E-01	.1995E-01
9	.1877E-01	.6870E-02	.2253E-02	.2989E-02	.2533E-02	.4398E-02	.5620E-02	.7843E-02	.2257E-01
10	.3009E-02	0.	.1290E-02	.1901E-02	.3652E-02	.1291E-03	.1750E-02	.2494E-03	.2691E-02
11	.1876E-02	0.	.3337E-03	.7380E-03	.1718E-03	.1002E-03	.1529E-02	.5809E-03	.4643E-03
12	.1042E-01	0.1196	.9557E-02	.1557E-01	.8158E-02	.3323E-02	.1588E-01	.5837E-02	.1960E-01
13	.2320E-03	0.	0.	0.	.3634E-03	.2685E-02	.1198E-02	.5460E-03	.6547E-03
14	.8266E-02	0.	.2206E-02	.2114E-01	.7508E-02	.7287E-02	.9732E-02	.6399E-02	.8695E-02
15	.3625E-02	0.	.9559E-02	.8455E-01	.3470E-02	.2871E-02	.4491E-02	.3413E-02	.4348E-02
16	.3466E-01	.4036E-01	.3456E-01	.4228E-01	.2909E-01	.5366E-01	.6101E-01	.6527E-01	.6419E-01
17	.3060E-01	.4036E-01	.6324E-01	0.1106	.4013E-01	.2495E-01	.3855E-01	.4479E-01	.3299E-01
18	.4362E-02	.4215E-02	.2765E-02	.3057E-02	.1779E-02	.3114E-02	.3166E-02	.5614E-02	.3366E-02
19	.2736E-01	.3601E-01	.1535E-01	.1828E-01	.1135E-01	.1844E-01	.1803E-01	.2569E-01	.1725E-01
20	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	.1421E-01	.8969E-02	.8824E-02	.1301E-01	.2461E-02	.2429E-02	.4491E-02	.3839E-02	.2557E-02
22	.3640E-03	0.	.4614E-03	0.	.3167E-03	.2771E-03	.2349E-03	.2677E-03	.3210E-03
23	.5800E-03	0.	.7353E-03	0.	.1893E-03	.4416E-03	.3743E-03	.8532E-03	.5115E-03
24	.7251E-04	0.	0.	0.	.6309E-04	0.	0.	0.	.2557E-03
25	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	0.1048	0.2601	0.1926	0.2715	0.1763	0.3049	0.2889	0.3267	0.1778

	10	11	12	13	14	15	16	17	18
1	0.	0.	.2807E-03	.2748E-02	.3423E-03	.9526E-03	.4276E-02	.7328E-03	0.
2	0.	0.	0.	0.	0.	0.	.7458E-03	0.	0.
3	0.	0.	0.	0.	0.	.3054E-02	0.	0.	0.
4	.5095E-01	.5317E-02	.3074E-03	.4012E-02	.1075E-01	.9799E-02	.1089E-03	.1070E-03	.4304E-03
5	.6122E-03	0.	.5614E-03	.2748E-02	0.	.1732E-03	.3535E-01	.1612E-02	0.
6	.1224E-02	.2081E-02	.1965E-02	.2198E-01	0.	.3464E-03	.5022E-02	.1759E-02	.5896E-03
7	.1259E-02	.5350E-03	.3898E-02	.8478E-02	.1760E-03	.3465E-01	.1253E-02	.6783E-03	.3032E-03
8	.1726E-01	.1956E-02	.9104E-02	.2325E-01	.2574E-02	.3745E-02	.2127E-01	.4822E-02	.7759E-02
9	.4127E-02	.9564E-03	.3613E-02	.8420E-02	.5245E-03	.9075E-02	.2057E-02	.4132E-02	.9034E-03
10	.5440E-01	.6082E-03	.1149E-02	.3213E-02	.4003E-03	.3934E-01	.5523E-03	.2570E-03	.3447E-03
11	.8336E-03	.9208E-01	.2134E-01	.8731E-02	.1554E-03	.2555E-02	.1354E-03	.1330E-03	0.
12	.1633E-01	.3203E-01	.8824E-01	.1316E-01	.3045E-02	.5332E-01	.6939E-02	.3660E-01	.6050E-02
13	.7837E-03	.6659E-03	.7186E-03	.1407E-01	.2191E-03	.9422E-03	.4137E-03	.1876E-03	0.
14	.1775E-01	.2809E-01	.9264E-02	.8244E-02	0.3437	.4244E-02	.1173E-01	.4104E-02	.4717E-02
15	.8571E-02	.2081E-02	.5755E-02	.2748E-02	.5478E-02	0.1619	.6116E-02	.3708E-01	.2358E-02
16	.4775E-01	.5930E-01	.6808E-01	.6595E-01	.1061E-01	.7266E-01	.4917E-01	.5027E-01	.1061E-01
17	.5939E-01	.3433E-01	.2905E-01	.3298E-01	.9586E-02	.2113E-01	.1775E-01	.6551E-01	.4835E-01
18	.3453E-02	.2934E-02	.4486E-02	.5166E-02	.2253E-02	.2361E-02	.1159E-01	.7302E-02	0.
19	.1622E-01	.1253E-01	.2265E-01	.2648E-01	.2254E-01	.2329E-01	.6827E-01	.2165E-01	.4734E-02
20	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	.6122E-02	.2081E-02	.4211E-02	.5496E-02	.2054E-02	.4070E-02	.1855E-01	.1715E-01	.2358E-02
22	.3842E-03	0.	.2642E-03	0.	.2148E-03	.3750E-02	.6552E-03	.2943E-02	.3700E-03
23	.6122E-03	0.	.4211E-03	0.	.7532E-02	.9786E-02	.1392E-02	.1612E-02	.5896E-03
24	0.	0.	.1404E-03	0.	.3423E-03	.8660E-04	.9944E-04	.1466E-03	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	0.3152	0.1635	0.3006	0.2744	0.1773	0.2429	0.3332	0.4340	0.6716

	19	20	21	22	23	24	25	26
1	.1194E-03	.8749E-03	.2008E-02	.3445E-02	.2108E-02	.1210E-01	0.	.2411E-01
2	0.	0.	0.	.1188E-03	0.	0.	0.	.4669E-03
3	0.	0.	0.	0.	.6044E-03	0.	0.	0.
4	.1744E-03	.5109E-02	.3664E-03	.1474E-02	.2052E-02	.2039E-02	0.	.8600E-03
5	.2389E-03	0.	.2008E-02	.5226E-02	.7027E-03	.1490E-01	0.	0.1116
6	.8360E-03	0.	.3513E-02	.3207E-02	.2108E-02	.3724E-02	0.	.7030E-01
7	.9212E-03	.1410E-01	.1548E-02	.1955E-02	.7227E-03	.4788E-02	0.	.1295E-01
8	.1942E-01	.4660E-02	.4246E-02	.1206E-01	.1453E-01	.7352E-01	0.	.1288E-01
9	.6221E-03	.9025E-02	.6690E-02	.3166E-02	.3661E-02	.3709E-02	0.	.2113E-01
10	.4887E-03	.5456E-02	.7335E-03	.6249E-03	.8217E-03	.3810E-02	0.	.1917E-02
11	.1084E-03	.2250E-02	.2278E-03	.2696E-03	0.	.4226E-03	0.	.3440E-03
12	.2860E-02	.1855E-01	.1614E-01	.9588E-02	.9134E-02	.5096E-02	0.	.3408E-01
13	.4586E-03	.3920E-02	.9636E-03	.7602E-03	.4498E-03	.6555E-02	0.	.8766E-03
14	.6927E-02	.2041E-02	.9787E-02	.1010E-01	.2178E-01	.5214E-01	0.	.1801E-01
15	.6449E-02	.7349E-01	.6524E-02	.3635E-01	0.2748	.5028E-01	0.	.1352E-02
16	.2377E-01	.4462E-01	.6524E-01	.2281E-01	.3725E-01	.6518E-01	0.	0.2766
17	.1063E-01	.7291E-02	.2384E-01	.2399E-01	.1546E-01	.4655E-02	0.	.2686E-01
18	.1931E-01	0.	.1746E-01	.9937E-02	.6606E-02	.3851E-01	0.	.1703E-01
19	0.1000	.8313E-01	.4554E-01	.2289E-01	.1918E-01	.4710E-01	0.	.6234E-01
20	0.	0.	0.	0.	0.	0.	0.	.8134E-01
21	.1218E-01	.2916E-03	.5270E-01	.1592E-01	.1265E-01	.2514E-01	0.	.6269E-01
22	.5246E-03	.1830E-03	.1102E-02	.8944E-03	.4410E-03	.1169E-02	0.	.3219E-02
23	.1553E-02	0.	.2509E-02	.7127E-03	.6184E-01	.1862E-02	0.	.1278E-02
24	.2389E-03	0.	.3011E-02	.5939E-03	.7027E-03	.1490E-01	0.	.9436E-02
25	0.	0.	0.	0.	0.	0.	0.	.1499E-02
26	0.2823	0.	0.2939	0.7350	0.4392	0.4143	1.000	0.

NOTES:

1. Sector 26 is the households sector adjusted for inclusion in the 'closed' table.

2. E-01 = 0.0...., E-02 = 0.00...., E-03 = 0.000.... etc,

Table 18

Multipliers from the 'Open' Otago Table

Sector[b]	Direct Income	Direct & Indirect Income	Type 1 Income Multiplier	Simple Output Multiplier
1	0.105	0.219	2.09	1.51
2	0.260	0.383	1.47	1.40
3	0.193	0.294	1.53	1.34
4	0.272	0.444	1.64	1.55
5	0.176	0.360	2.04	2.00
6	0.305	0.468	1.54	1.56
7	0.289	0.433	1.50	1.50
8	0.327	0.416	1.27	1.27
9	0.178	0.273	1.54	1.31
10	0.315	0.455	1.44	1.44
11	0.163	0.270	1.65	1.39
12	0.301	0.418	1.39	1.38
13	0.274	0.386	1.41	1.36
14	0.177	0.326	1.84	1.69
15	0.243	0.449	1.85	1.70
16	0.333	0.444	1.33	1.38
17	0.434	0.555	1.28	1.37
18	0.672	0.716	1.07	1.13
19	0.282	0.373	1.32	1.27
20	0.000	0.114	-	1.40
21	0.294	0.413	1.40	1.37
22	0.735	0.818	1.11	1.27
23	0.439	0.668	1.52	1.79
24	0.414	0.603	1.46	1.62
25	1.000	1.000	1.00	1.00
Aggregate Multipliers[a]			1.54	1.51

[a] The average of the sectoral multipliers weighted by the output of each sector.

[b] For list of sectors see Appendix 7.

Table 19

Multipliers from the 'Closed' Otago Table

Sector[b]	Direct Income	Direct, Indirect & Induced Income	Type 2 Income Multiplier	Total Output Multiplier
1	0.105	0.330	3.15	1.93
2	0.260	0.577	2.22	2.13
3	0.193	0.444	2.30	1.90
4	0.272	0.670	2.47	2.39
5	0.176	0.543	3.08	2.69
6	0.305	0.706	2.31	2.45
7	0.289	0.652	2.26	2.32
8	0.327	0.628	1.92	2.06
9	0.178	0.412	2.32	1.83
10	0.315	0.686	2.18	2.30
11	0.163	0.407	2.49	1.90
12	0.301	0.630	2.09	2.17
13	0.274	0.582	2.12	2.09
14	0.177	0.491	2.77	2.31
15	0.243	0.676	2.78	2.55
16	0.333	0.669	2.01	2.22
17	0.434	0.837	1.93	2.42
18	0.672	1.079	1.61	2.48
19	0.282	0.562	1.99	1.98
20	0.000	0.172	-	1.61
21	0.294	0.622	2.12	2.15
22	0.735	1.233	1.68	2.82
23	0.439	1.008	2.29	3.06
24	0.414	0.909	2.19	2.77
25	1.000	1.507	1.51	2.90
Aggregate Multipliers[a]			2.40	2.30

[a] The average of the sectoral multipliers weighted by the output of each sector.

[b] For list of sectors see Appendix 7.

Table 20

Estimation of Employment Vector

Sector	(1) Change in Employment 1971-76	(2) Change in Gross Output 1971/72-1976/77 $m	(3) Change in Gross Output 1971/72-1976/77 in real terms[c] $m	(4) Estimated Change in employment per $1m increase in real Gross Output 1971/72-1976/77 (1) ÷ (3)
1	) 4,300[a]	) 1,262.5	) 734.0	5.85
2	)	)	)	
3	800	90.0	52.3	15.2
4	-206	122.5	71.2	0.0
5	5,100	1,179.7	685.9	7.44
6	-3,000	432.4	251.4	0.0
7	2,800	337.4	196.2	14.3
8	1,600	567.8	330.1	4.85
9	1,300	942.3	547.8	2.37
10	300	188.5	109.6	2.74
11	)	)	)	17.3
12	) 15,400[a]	) 1,530.7	) 889.9	17.3
13	)	)	)	17.3
14	2,056	324.9	188.9	10.8
15	18,449	1,848.3	1,074.6	17.1
16	17,807	2,988.8	1,737.7	10.2
17	) 8,100[a]	) 1,141.1	) 663.4	12.2
18	)	)	)	12.2
19	15,018	888.7	516.7	29.1
20[b]	-	-	-	-
21	29,900	462.5	268.9	111.0
22	) 12,600[a]	) 1,152.8	) 670.2	18.8
23	)	)	)	18.8
24	2,000	98.6	57.3	34.9
25	900	1.9	1.1	818.0

[a] Insufficient employment data to disaggregate.

[b] Ownership of Dwellings sector - no direct employment

[c] Consumer "All Group" price index used to deflate Column 2. Over the period 1971-76 this index rose by 72 per cent.

Source: -New Zealand Yearbook 1972 and 1978
-Census of Population and Dwellings 1971 and 1976, Dept.of Statistics.
-Inter-Industry Study of the New Zealand Economy 1971/72 (25 sector model) and updated version for 1976/77, Department of Statistics.

Table 21

Employment Multipliers for Otago

Sector[a]	Direct Employment[b]	Direct and Indirect Employment[b]	Type 1 Employment Multiplier	Direct, Indirect and Induced Employment[b]	Type II Employment Multiplier
1	5.9	13.1	2.24	20.5	3.50
2	5.9	13.2	2.25	26.1	4.46
3	15.2	21.3	1.40	31.2	2.06
4	0.0	8.9	-	23.9	-
5	7.4	17.3	2.33	29.4	3.95
6	0.0	4.4	-	20.2	-
7	14.3	22.3	1.56	36.8	2.58
8	4.9	9.1	1.87	23.1	4.76
9	2.4	6.6	2.78	15.8	6.66
10	2.7	8.3	3.03	23.6	8.63
11	17.3	23.4	1.35	32.5	1.88
12	17.3	23.7	1.37	37.7	2.18
13	17.3	22.6	1.31	35.6	2.06
14	10.8	19.7	1.82	30.6	2.84
15	17.1	27.9	1.63	43.0	2.51
16	10.2	17.9	1.75	32.8	3.22
17	12.2	19.6	1.61	38.3	3.14
18	12.2	14.2	1.17	38.3	3.14
19	29.1	35.8	1.23	48.3	1.66
20	0.0	7.1	-	11.0	-
21	111.0	122.2	1.10	136.1	1.23
22	18.8	24.5	1.30	52.0	2.77
23	18.8	32.7	1.74	55.2	2.94
24	34.9	46.2	1.32	66.5	1.91
25	818.0	818	1.00	851.7	1.04

[a] For List of Sectors, see Appendix 7

[b] Employment per $1m increase in final demand of sector.

It is likely that the actual multipliers in the Otago region are smaller than those shown in Tables 18, 19 and 21. As pointed out earlier, the Census of Industrial Production data on output in the manufacturing sectors indicate that the location quotient approach has over-estimated regional production in these sectors. This may equally apply to the non-manufacturing sectors, in which case inter-industry transactions and their multiplier effects will be overstated. In addition, Morrison and Smith (1974) and Schaffer and Chu (1966) found that the regional multipliers obtained from adjusted national tables were higher than those from corresponding survey based tables. In their study of the State of Washington, Schaffer and Chu, using the simple location quotient approach, found that their estimates of the Type 1 income multipliers were, on average, 21 per cent higher than those from the survey based model, and their estimates of the Type 2 multipliers 47 per cent higher.

The non-survey input-output table for Otago developed in this chapter could be considerably refined. With the use of more detailed employment statistics the adjustment procedures could be applied to the 130 sector table of the New Zealand economy. Refinement might also include a recalculation of the row and column coefficients of the agricultural sector so that they more closely reflect the overall farming pattern in Otago.

In this and the previous two chapters, alternative approaches to estimating regional multipliers have been demonstrated. These approaches are by no means mutually exclusive and, indeed, it is possible for them to be used in combination. For example, an export base multiplier can be derived from the information detailed in the I-O model of the region as can the local income component of consumption expenditure in the Keynesian model. However, with the availability of a satisfactory regional input-output table the alternative approaches are likely to become redundant.

CHAPTER 7

ESTIMATED TOTAL IMPACTS

In this chapter the localised secondary impact of the investment in the Lower Waitaki and Morven-Glenavy Irrigation Schemes is estimated. The net injections into the region are combined with the regional output, income and employment multipliers to produce estimates of the total (direct, indirect and induced) output, income and employment impacts.

7.1 Net Regional Injections

In Chapter 3, the total net injections, 1970/71 to 1977/78, resulting from the Morven Glenavy and Lower Waitaki Irrigation Schemes were estimated at $17.8m within the area encompassed by Waimate and Waitaki Counties. Of this direct impact, one half can be attributed to on and off-farm construction expenditures, 49 per cent to increased agricultural production, and 1 per cent to scheme operation and maintenance expenditures. If the study area is enlarged to include all the Otago S.A. plus Waimate county, total net injections over the same period can be estimated at $19.9 million by assuming that half of the direct leakages from the smaller region accrue to persons and firms in Otago. It is assumed that the other half is "leaked" into the remainder of the Canterbury S.A.

7.2 Regional Multiplier Estimates

Values for several kinds of regional multiplier have been estimated in Chapters 4-6. These multiplier estimates relate to output, personal income and employment, and, depending on the method of estimation, they can embody the indirect impact, the induced impact, or both. In estimation of the total output, income and employment impacts only those multipliers that embody both the indirect and induced impacts are of interest, and it is from these multipliers that the most appropriate estimates are selected. Output, income and employment multipliers are now each examined in turn.

7.2.1 Output Multipliers. The output multiplier estimates for a variety of regional definitions, from Oamaru borough to the Otago S.A., as derived in Chapters 4-6, are summarised in Table 22. These estimates need to be interpreted with care for a number of reasons.

Firstly, in the estimation of the multipliers most of the data pertained in 1971/72. It is unfortunate not to be able to generate estimates for more recent years to see how changes in the local economy over the period in question, have affected, if at all, the estimates for 1971/72. However, given the existing data, the 1971/72 estimates are the most recent available.

Secondly, it should be remembered that not all of the multiplier estimates refer to the same region. The export base multiplier estimated by regression pertains to Oamaru borough (the major urban centre in the immediate study area), the other export base multiplier to Waimate and Waitaki Counties, and the input-output multipliers to the Otago S.A. Generally, the larger the regional definition the greater the multiplier value is expected to be.

Table 22

Regional Multiplier Estimates - Output

Regional Definition	Multipliers[a]	Basis for Estimates	Year	Value of Estimate
Oamaru borough	Aggregate	Export Base - regression (p 53)	1953-70	1.8 - 2.1
Waimate county	"	Export Base - ratio (p 49)	1971	2.31
Waitaki county	"	"	"	3.23
Waimate & Waitaki counties combined	"	"	"	3.09
Otago S.A.	"	Input-Output Table (pp 90)	1971-72	2.30
"	Agriculture	"	"	1.93
"	Construction	"	"	2.55

[a] These multipliers embody direct, indirect and induced output.

Thirdly, the multipliers from both the export base and input-output models are likely to be overstated. With reference to the export base model, the location quotient approach tends to underestimate basic activity and, therefore, to overestimate the multiplier (see pp 40-41). Greater dissaggregation of the employment-by-industry data and an allowance for national exports were both found to reduce the export-base multipliers but, unfortunately, the scarcity of more detailed data limited the scope for this form of adjustment, with the result that the estimates in Table 22 are undoubtedly overstated.

Similarly, the output multipliers derived from the input-output table for Otago are likely to be considerably larger than their counterparts from a more accurate survey based table. As was pointed out in Chapter 6, Schaffer and Chu (1969) and Morrison and Smith (1974), in using the simple location quotient approach, found that the multipliers from their non-survey tables were substantially overstated when compared with those from survey-based tables. Location quotients are, again, partly to blame; this time for underestimating regional imports[30]. This means, of course, that the multiplier estimates are overstated because the a_{ij} coefficients in the transactions matrix of the table are

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[30] The total number of export workers (or output) in a region, estimated using location quotients of greater than one, will equal the total number of 'deficit' workers estimated using location quotients of less than one. Therefore, an underestimate of exports will also mean an underestimate of imports.

overstated.

Furthermore, the use of a gross national table in the GRIT procedure is, as the authors point out, likely to overstate intra-sectoral transactions at the regional level with the result of, again, overstating the a_{ij} coefficients in the transactions matrix. The alternative approach is to use a net table as the basis for the adjustment procedure, and so have zeros in the leading diagonal in the transactions matrix. However, this is open to the criticism that it may underestimate regional intra-sectoral transactions. In deriving the input-output table for Otago, a gross national table for New Zealand was used, and so the multiplier estimates probably incorporate an overstatement of regional intra-sectoral transactions.

The estimated aggregate multiplier for Otago of 2.30 (input-output approach) can be compared with the aggregate multiplier for the two counties of 3.09 (export base approach). Given the above comments and the reliability of the two approaches, the most likely aggregate output multiplier for the Otago S.A. would seem to be closer to 2, and for Waimate and Waitaki counties, probably less than 2. Similarly, the sectoral multipliers available from the input-output table for Otago should be interpreted as the upper limits of a range. Multiplier estimates or 1.5 - 1.9 for the agricultural sector and 2.0 - 2.6 for the construction sector would seem, therefore, more appropriate.

<u>7.2.2 Income Multipliers</u> The income multipliers for the Otago S.A. in Table 23 relate to the household income component of output. They are Type II income multipliers (see pp73-74); that is, they are a measure of the indirect and induced household income generated given an initial increase in household income. In this respect, they differ from the output multipliers of the previous section which give an indication of the indirect and induced output generated from a $1 increase in direct output. The total increase in household income per $1 increase in direct output is given by the direct, indirect and induced income coefficients from the 'closed' input-output table (see Table 19).

The Keynesian multiplier of 1.37 estimated for the combined Waimate and Waitaki counties is considerably lower than the input-output multiplier of 2.40 estimated for the Otago S.A. However, aside from the difference in regional definition the two multipliers are not comparable. It may be recalled that in estimating the c-m component of the Keynesian multiplier, all inter-industry transactions were assumed to be non-local (see p58). This multiplier, therefore, understates total household income by an amount corresponding to the wages and salaries generated by local inter-industry purchases. As such, the Keynesian multiplier is of little use in determining the <u>total</u> impact on household income in the region. Consequently, attention will be focussed on the income multipliers from the input-output table for the Otago S.A.

Table 23

Regional Multiplier Estimates - Income

Regional Definition	Multiplier	Basis for Estimation	Year	Value of Estimate
Waimate and Waitaki Counties combined	Aggregate	Keynesian Model (p65)	1971/72	1.37
Otago S.A.	Aggregate[a]	Input-Output Table (p90)	"	2.40
"	Agriculture[a]	"	"	3.15
"	Construction[a]	"	"	2.78

[a] These are Type II Income multipliers and encompass direct, indirect and induced income.

As with the output multipliers, the income multipliers from the input-output table for Otago are likely to be overstated. The Type II sectoral income multipliers for the agricultural and construction sectors are 3.15 and 2.78 respectively. Although both are higher than the aggregate income multiplier of 2.40 this does not necessarily imply that total wages and salaries generated by a direct increase in output in the agricultural and construction sectors are greater than when the initial increase is in some other sector or sectors. It may simply be that salaries and wages in these sectors, as a proportion of total inputs, are lower than the regional average for all sectors. This is certainly the case with agriculture.

7.2.3 Employment Multipliers: The only employment multiplier estimates derived are those from the input-output table for Otago[31] (see Table 21, p 92). These can be interpreted in a similar way to the income multipliers. The sectoral multiplier estimates for agriculture and construction of 3.50 and 2.51, respectively, relate to the direct, indirect and induced increase in employment resulting from an increase in direct employment.

7.3 Regional Impacts

In this section the net regional injections and the regional multipliers are combined to obtain estimates of the total output, income and employment impacts on the regional economy. It should be pointed out here that although it is theoretically possible, with multiplier estimates, to assess the overall impact on the regional economy of a direct injection, it is another matter to

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[31] With the export base model employment was used as a proxy for output and so the model can, with some justification, be regarded as providing more of an employment multiplier than an output multiplier.

estimate the time horizon over which the multiplier effects will operate. Some investments may have an immediate impact on the regional economy, others a more gradual one. The likely time lags involved with the secondary impact of an investment are relevant to regional development and should not be overlooked. However, as with the secondary effects themselves, the time lags involved are far from easy to quantify.

Furthermore, in estimating the total output, income and employment impacts, a distinction should be made between the short term and the long term. In the case of irrigation the secondary impact resulting from on and off-farm construction will only be of a temporary nature, since once the development phase is over the demand and derived demand for goods and services associated with the construction will be withdrawn. However, increases in output, income and employment generated by increased agricultural production and the operation and maintenance expenditures are likely to be more permanent, since injections into the economy will be sustained. Generally, of the secondary impact generated by an irrigation scheme, that part associated with the construction expenditures will only be short lived, whereas that stimulated by increased agricultural production is likely to be more permanent.

In this section the multipliers used to estimate the total impact of the irrigation schemes on the regional economy are those derived from the input-output model. Consequently, the regional definition used throughout the remaining part of this chapter is that of the Otago S.A. plus Waimate County.

7.3.1 Output Impact. The output impacts resulting from the Morven-Glenavy and Lower Waitaki Irrigation schemes over the period 1970/71 - 1977/78 are shown in Table 24. Each multiplier estimate in this table has been taken as the mid-point in the range suggested in the previous section of this chapter. In light of the earlier comments on the output multiplier estimates, it would still be wise to regard even these mid-range estimates as representing upper limits.

The overall magnitude of the secondary impact on output in the region is estimated at $20.7m. This figure can be interpreted as follows. Over the period 1970/71 to 1977/78 the development of the Morven-Glenavy and Lower Waitaki Irrigation Schemes involved a direct injection of just under $20m into the economy of Otago and the adjacent Waimate county. This expenditure generated further output of an estimated $20.7m in the region as a result of the increased sales and purchases of firms servicing the agricultural and construction sectors, and from the wages and salaries generated by this increased local production. Note that the increase in output, over and above the direct effects in the agricultural and construction sectors, is probably shared amongst all sectors in the local economy.

Table 24

Estimated Impact on Total Output 1970/71 - 77/78

Region	Net Injections (Direct Output)	Total Output Multiplier	Total Output Impact (Direct, indirect and induced output)
	$m		$m
Otago S.A. plus Waimate county			
- Agriculture	8.7	1.7	14.8
- Construction	11.2	2.3	25.8
	19.9		40.6

7.3.2 Income and Employment Impacts. Income and employment impacts have been estimated for the region, that is the Otago Statistical Area plus Waimate county, using the income and employment multipliers from the Otago I-O table. These multipliers have not been reduced and are as they appear in Tables 19 and 21 in Chapter 6.

The total impact of the irrigation schemes on regional income over 1970/71 - 77/78 is estimated at $10.3m, given a direct impact of $3.6m (see Table 25); the latter is calculated from the direct income coefficients in the Otago I-O table. The direct impact on incomes in the agricultural sector may be overstated for reasons explained in the following section on employment impacts.

To estimate the impact of the irrigation schemes on local employment it is necessary to express the annual direct injections over the 1970/71-1977/78 period in 1971 prices. This is because in the employment vector, used to estimate the employment multipliers from the I-O table, the increase in employment per increase in real output was estimated in terms of 1971 prices. The deflated annual direct injections in the agricultural and construction sectors are shown in columns 1 and 6, respectively, of Table 26. The direct employment created by these injections is estimated using the direct employment coefficients of the employment vector (see p 92). The total employment impact (i.e. direct, indirect and induced employment) in the region is then estimated using the Type II employment multipliers from the Otago I-O table.

Columns 5 and 10 of Table 26 show that the irrigation schemes created local employment for an estimated 439 persons over the period 1970/71 - 1977/78; 107 jobs as a result of the increase in agricultural production and 332 created by the construction and operation and maintenance expenditures.

Table 25

Estimated Impact on Total Income 1970/71 - 77/78

Region	Direct Injection $m (1)	Direct Income per $1 output[a] (2)	Direct Income $m (3)	Type II Income Multiplier (4)	Total Income $m (5)
			(1) x (2)		(3) x (4)
Otago S.A. plus Waimate county					
-Agriculture	8.7	.105	0.9	3.15	2.8
-Construction	11.2	.243	2.7	2.78	7.5
	19.9		3.6		10.3

Several points should be noted when interpreting this employment impact. Firstly, in the estimation of the employment vector used to derive the employment multipliers, employment had to be measured in terms of the number of persons 'actively engaged' in an industry or sector. This means that the employment estimates in Table 26 may not necessarily represent full-time equivalents.

Secondly, it will be remembered that the employment vector was chosen to represent changes in employment at the margin rather than average employment/output ratios. Although it was felt that this would provide a more appropriate indication of changes in employment per change in output, it does mean that the estimate of total employment should be contrasted to,

TABLE 26

Estimated Impact on Total Employment 1970/1 - 1977/8

Year	Agriculture					Construction				
	Direct Injections in 1971 prices[a]	Direct Employment per $1m output[b]	Direct Employment	Type II Employment Multiplier	Total Employment	Direct Injections in 1971 prices[a]	Direct Employment per $1m output[b]	Direct Employment	Type II Employment Multiplier	Total Employment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$					$				
1970/1	-	5.9	-	3.50	-	)				
1971/2	-	"	-	"	-	) 1,517,000	17.1	26	2.51	65
1972/3	316,300	"	2	"	7	1,218,700	"	21	"	52
1973/4	578,400	"	3	"	12	1,336,900	"	23	"	57
1974/5	512,300	"	3	"	11	1,169,500	"	20	"	50
1975/6	1,164,000	"	7	"	24	1,042,800	"	18	"	45
1976/7	1,387,100	"	8	"	29	801,400	"	14	"	34
1977/8	1,207,700	"	7	"	25	639,700	"	11	"	27
Totals	5,165,800	-	30	-	107[c]	7,726,000[d]	-	132[c]	-	332[c]

[a] Price deflators are given in Appendix 9

[b] Direct employment coefficient used in the Otago I-O table (see p. 92).

[c] Column does not sum to total due to rounding

[d] Direct injections exclude $875,000 on spray irrigation

rather than compared with, the estimate of total household income, to which employment is obviously related. As such, the estimates of total income and employment can be interpreted as being based on average and marginal changes, respectively, per change in output.

Thirdly, the employment vector assumes a linear relationship between employment and output, so that any increase in the latter will lead to a proportional increase in employment. Related to this is the assumption that all sectors in the local economy are operating at full capacity. If, for any reason, some industries in the region are operating at less than full capacity, then there is likely to be an opportunity for these industries to increase their output without increasing their employment.

Similarly, from the farm surveys conducted on both the Morven-Glenavy and Lower Waitaki irrigation schemes and from personal communication with M.A.F. advisers in the area, it would appear that, in the majority of cases, farmers have not employed extra full-time labour, but have, instead, increased their own workload. The farms on these schemes employ little other than family labour and the decision to employ extra full-time labour is likely to be a major one at the individual farm level. The direct employment in agriculture of 30 persons over the 1970/71 - 1977/78 period as a result of the irrigation schemes is, therefore, probably an over-estimate. For this reason the estimate of direct income in the agricultural sector may also be overstated, depending on how individual farmers have priced their own labour.

CHAPTER 8

SUMMARY AND CONCLUSIONS

This study has been concerned with estimating the regional impact of the Morven-Glenavy and Lower Waitaki irrigation schemes and has concentrated on quantifying the total increase in local economic activity stimulated by these schemes. This total increase in economic activity, estimated in terms of output, income and employment, is referred to as the secondary impact, encompassing the indirect and induced effects generated by an initial injection into the regional economy.

In any regional study one of the first steps is to define the bounds of the region. As is common in such studies, availability of data imposes the main restriction on what can, and what cannot, be designated as a region. In the present study, Waimate and Waitaki counties have been combined to form the immediate region surrounding the Lower Waitaki irrigation schemes. However, the need to make use of existing data meant that this particular definition of the region could not be adhered to throughout, and in estimating the total impacts in Chapter 7, the Otago S.A. and Waimate county were combined to form 'the region'.

Injections into the regional economy as a result of irrigation development were estimated in terms of increased agricultural output, on and off farm construction, and operation and maintenance expenditures. Total injections over the life of the Morven-Glenavy and Lower Waitaki schemes to 1977/78 were estimated at $17.8m for Waimate and Waitaki counties and $19.9m for the Otago Statistical Area and Waimate county, net of any immediate leakages from the regions.

Having estimated the net regional injections, attention was focussed on the regional multiplier effects, and to this end three methods of estimating multipliers for the Lower Waitaki region were demonstrated. The methods differed in terms of accuracy and data requirements - the input-output model being the most comprehensive but requiring the most data, the export base model being the most aggregate but requiring the least data.

The values estimated for the regional multipliers vary with the method used, but in general there was overall concensus within a narrow range. Using the multiplier estimates for the larger of the two regional definitions, the initial injection of $19.9m in the agricultural and construction sectors over the period 1970/71 - 77/78 resulted in a total increase in regional output of $40.6m. The total increase in personal income was estimated at $10.3m, and employment at 439 person years. For a number of reasons these estimates may be overstated, but they do indicate the order of magnitude of likely regional economic impacts.

The secondary impact on a particular region of an investment programme is a function of the economic activity stimulated within that region. In quantifying this increased economic activity, the present study has shown the direct injections and the regional multiplier effects to be important parameters for estimation. Unfortunately, the scarcity of regional data makes the estimation of these parameters particularly difficult. The present study, in attempting to quantify the secondary impact in a specific region, has not been able to show whether regional multipliers differ significantly between regions. Even if it is felt, intuitively, that regional differences in the size of the multiplier do exist, the available data may be of insufficient quality and detail for these differences to be quantified. This highlights an area for further research, namely the estimation of multipliers for various regions. To this end, non-survey regional input-output models could be derived for the whole of New Zealand, which, as well as providing for a comparison of multipliers in various regions, could also be used for purposes of reference where regional impact analysis was of interest.

As was mentioned in the first chapter of this report, the relevance of the secondary impact in investment appraisal depends largely on whether it is viewed in terms of its effect on the economy of the nation or a region. At the national level, secondary impacts may affect aggregate output in the economy depending on the overall level of resource employment. At the regional level, the secondary impact is likely to be important in terms of regional development, regardless of its effect on the national economy. Whichever viewpoint is adopted it would seem, at the very least, useful to have the secondary impact quantified. With a greater appreciation of the secondary effects, they may, in future, assume a more important role in investment appraisal and feature more prominently alongside the direct effects by which alternative investments have hitherto been ranked.

REFERENCES

Archibald, G. C., 1976. "Regional Multiplier Effects in the UK", Oxford Econ. Papers, Vol. 19, No. 1, pp 22-45.

Bergmann, H. and Boussard, J. M., 1976. "Guide to the Economic Evaluation of Irrigation Projects (Revised Edition). O.E.C.D. (Paris)

Billings, B., 1969. "The Mathematical Identity of the Multipliers Derived from the Economic Base Model and the Input-Output Model", J. Reg. Sc. Vol. 9, No. 3, pp 471-3.

Boisvert, R.N. and Bills, N.L., 1976. "A Non-Survey Technique for Regional Input-Output Models" A.E. Res. 76-19 Cornell Uni./USDA.

Borlin, Max., 1971. "Econometric Model for River Basin Planning", O.E.C.D., Paris.

Brown, W.A.N., 1978. "The Economics of Irrigation to the Nation", paper delivered to the New Zealand Irrigation Association Conf., Ashburton.

Burford, R.L. and Katz, J.L, 1977. "Regional Input-Output Multipliers Without a Full I-O Table", Annals of Reg. Sc., Vol. 11, No. 3, pp 21-38.

Butterfield and Mules, 1977. "The Proceedings of the Input-Output Workshop", ed. Mandeville, T.D., Second Meeting of the Australian and NZ Section of the Regional Science Assoc., Univ. N.S.W.

Chenery, H.B. and Clark, P.G., (1962). "Interindustry Economics".

Ching, C.T.K and Kwanu, F.E., 1978. "Economic Impact in the Pahrump Valley - An Application", University of Nevada Reno.

Deane, R.S. and Giles, D.E., 1972. "Consumption Equations for New Zealand. Tests of Some Alternative Hypotheses", Reserve Bank of New Zealand, Research Paper No. 6.

Galway, D. de B., 1977. "The Impact of the Proposed Kakanui-Waireka Irrigation Scheme on the North Otago Region", Tech Paper 11/77, M.A.F. (Econ. Div).

Garnick, D.H, 1969. "Disaggregated Basic-Service Models and Regional I-O Models in Multiregional Projections", J. Reg. Sc., Vol. 9, pp 87-100.

Garnick, D.H., 1970. "Differential Regional Multiplier Models", J. Reg. Sc., Vol. 10, No. 1, pp 35-47.

Griffiths, (1971). NZ J. Sc., 14, pp 524-553.

Hodge I. D. and Whitby M. C., (1979). Jobs in the Eastern Borders : An Economic Assessment of the Development Commission Factory Programme, Agricultural Adjustment Unit, Monograph No. 8, Uni. of Newcastle upon Tyne, England.

Hoover, E.M., 1975. "An Introduction to Regional Economics", Second Ed.

Inter-Industry Study of the New Zealand Economy, 1971-1972. Department of Statistics, Wellington.

Isard, W. and Czamanski, S., 1965. "Techniques for Estimating Local and Regional Multiplier Effects of Changes in the Level of Major Government Programs ", Peace Research Society : Papers III, Chicago Conference.

Isard, W., (et al) 1967. "Methods of Regional Analysis - An Introduction to Regional Science", M.I.T. Press.

Jensen, R.C., Mandeville, T.D., and Karunaratne, N.D., 1977. "Generation of Regional Input-Output Tables for Queensland." Dept. of Econ., Univ. of Queensland.

Kalter, R.J. and Lord, W.B., 1968. "Measurement of the Impact of Recreation Investments on a Local Economy", Am. J. of Ag. Econ, Vol. 50, No. 2, pp 243-56.

Kimball, N.D. and Castle, E.N, 1963. "Secondary Benefits and Irrigation Project Planning", Technical Bulletin 69, Oregon State Uni./USDA.

Lamphear, F.C. and Roestler, T.W., (1974). "Impact Analysis of Irrigated Agriculture on Nebraska's Economy 1967-70", Bureau of Business Research, Uni. of Nebraska - Lincoln.

Mandeville, T.D., (ed), 1977. "Proceedings of the Input-Output Workshop", Second Meeting of the Australian and NZ Section of the Regional Science Assoc., Uni. of NSW, Dept of Econ., Univ. of Queensland.

Mattila, J.M. and Thompson, W.R., 1955. "The Measurement of the Economic Base of the Metropolitan Area", Land Economics, Vol. 31, pp 215-228.

McColl, E.D. and Throsby, C.D. 1971. "Regional Multiplier Estimation in Benefit-Cost Analysis and Possible Applications in Australia", Australian and NZ Association for the Advancement of Science, 43rd Congress, Brisbane, Section 24, Economics.

Miernyk, W.H., 1965. "The Elements of Input-Output Analysis".

M.A.F., (1977). "Cost Benefit Procedures in New Zealand Agriculture", Economics Division.

Moore, B. and Rhodes, J., (1978). "The Economic and Exchequer Implications of British Regional Economy Policy", Economics Reprint No. 27, Uni. of Cambridge.

Morrison, W.I., and Smith, P. (1974). "Non-Survey Input-Output Techniques at the Small Area Level - An Evaluation", J. Reg. Sc., Vol. 14, No. 1, pp 1-14.

Richardson, H.W., 1970. "Elements of Regional Economics", Penguin Modern Economics.

Ross, B. J., 1973. "A Case for Agriculture", Proceedings of the 1973 Regional Development Seminar, pp 50-59, Dunedin

Schaffer, W.A., and Chu, K. (1969). "Non-Survey Techniques for Constructing Regional Interindustry Models", Papers of the Regional Science Assoc. Vol. XXIII, pp 83-101.

Se - Hark Park, (1970). "Least Squares Estimates of the Regional Multiplier - An Appraisal", J. Reg. Sc., Vol. 10, No. 2, pp 175-189.

Steele, D.B. (1969). "Regional Multipliers in G.B.", Oxford Econ. Papers, Vol. 21, pp 268-292.

Terry, E.F. (1965). "Linear Estimators of the Export Employment Multiplier", J. Reg. Sc., Vol. 6, No. 1, pp 17-34.

Watkins, D.C., "The Morven-Glenavy Irrigation Scheme - An Economic Report", MAF (Econ. Div.), Hamilton.

Weiss, S.J. and Gooding, E.C., (1968). "Estimation of Differential Employment Multipliers in a Small Regional Economy", Land Economics, Vol. 44.

Wilson, T., (1968). "The Regional Multiplier - A Critique", Oxford Econ. Papers, Vol. 20, pp 374-393.

APPENDIX 1

A Note on Cost - Benefit Analysis

The methodology for application of cost-benefit analysis to investment appraisal in the agricultural sector of New Zealand is outlined in a recent handbook prepared by the Economics Division of the MAF (1977). In the evaluation of irrigation schemes the MAF only quantifies direct, or primary, costs and benefits. As the MAF points out, although secondary costs and benefits are quantifiable, the question as to whether they should be included in cost-benefit analysis has led to widespread controversy. In its own studies, the MAF prefers to confine the analysis to those costs and benefits that 'are incurred or created within the project itself', and so quantifies only the primary impacts.

In estimating primary costs and benefits, the agricultural product prices used by the MAF are those at the point of first scale (i.e. farm gate prices). However, if increased agricultural production is to be exported, then a case may be made for using f.o.b. prices rather than those at the point of first sale. This would, effectively, extend the primary benefits to cover those activities between farm gate and f.o.b., e.g. meat freezing and processing. In terms of the split between primary and secondary effects, this approach means quantifying as primary, some benefits and costs which are normally categorised as secondary. The extent to which these additional benefits and costs can be incorporated in an internal rate of return or net present value depends on the likely effect on aggregate output from the national viewpoint and, therefore, the degree to which unemployed or underemployed resources exist in the economy.

APPENDIX 2

Farm Surveys

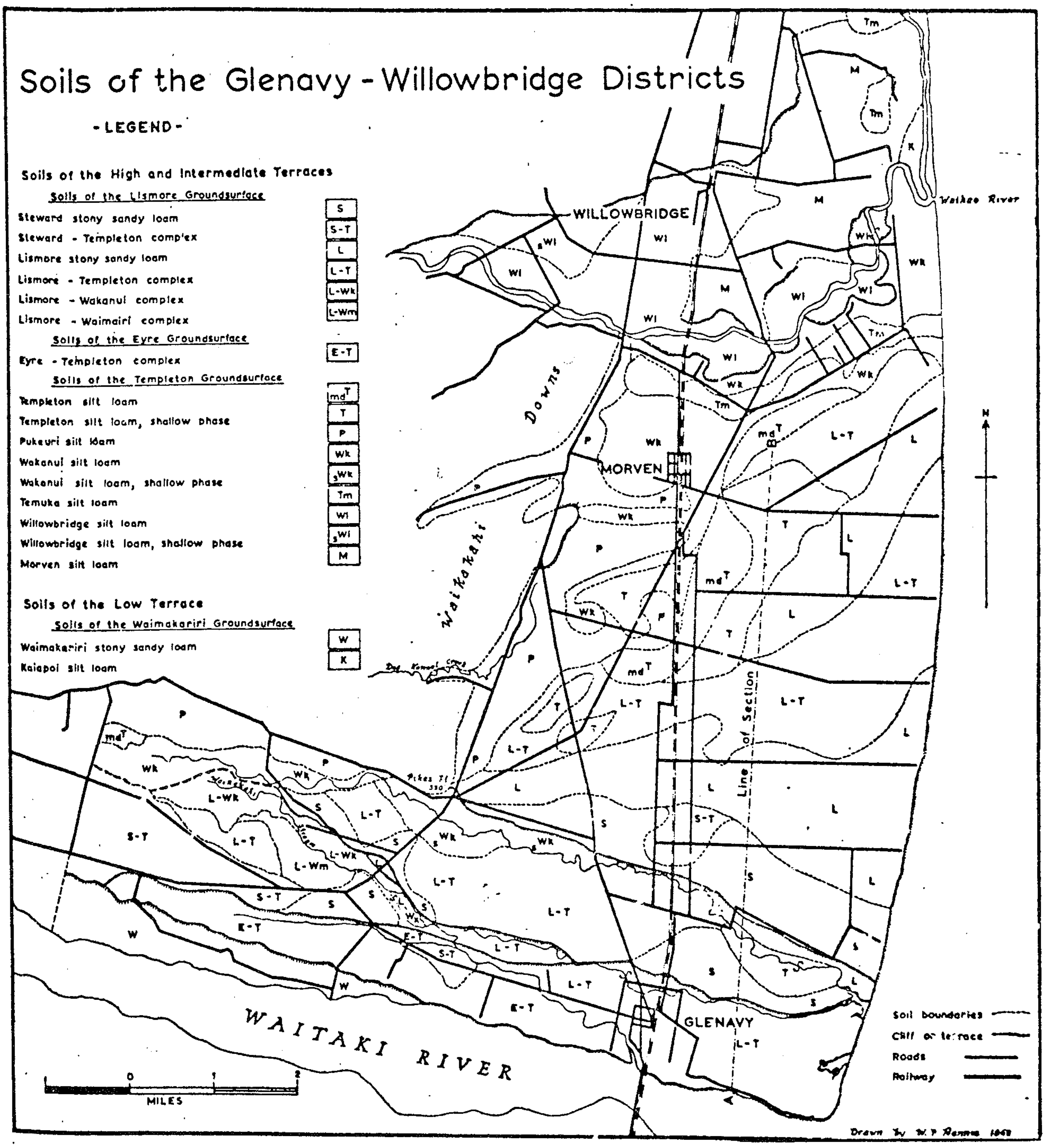
The increase in agricultural production resulting from the Morven-Glenavy and Lower Waitaki irrigation schemes was estimated from farm survey data collected in November and December 1978. The two surveys were quite separate, the Lower Waitaki survey being carried out by the MAF and the Morven-Glenavy survey being undertaken by the A.E.R.U. with assistance from the MAF.

1. The Morven-Glenavy Survey

The soils of the Morven-Glenavy Scheme area have been comprehensively documented by Griffiths (1971) who classified them by origin (Fig. 5) and irrigability (Table 27). The latter stratification dividies the soils into four classes "according to their topography, available moisture, effective rooting depth and drainage" (Griffiths, 1971 : 541) and the relevant data are reproduced as Table 27. Griffith's soil survey area does not exactly duplicate the boundaries of the Morven-Glenavy Irrigation Scheme; in fact, it includes around 10,230 ha of the scheme area, which have been classified as Class 1, 1050 ha (10.3%); Class 2, 320 ha (3.1%); Class 3, 5340 ha (52.2%); and Class 4, 3520 ha (34.4%).

Figure 5

Soil Map of Glenavy-Willowbridge District



Source: Griffiths (1971).

Table 27

Irrigability Classification and Areas of Soils in the Glenavy-Willowbridge District

		Area (hectares) - nearest 10 hectares
Class 1 - Eminently Suitable for Irrigation		
Pukeuri silt loam		
Willowbridge silt loan		890
	Total	1,940
Class 2 - Suitable for Irrigation		
Templeton silt loan		320
	Total	320
Class 3 - Slightly Restricted Suitability for Irrigation		
(a) Well drained to moderately well drained:		
Lismore-Templeton complex		2,830
Steward-Templeton complex		490
Templeton silt loam, shallow phase		610
Willowbridge silt loam, shallow phase		160
(b) Imperfectly drained:		
Wakanui silt loam		1,050
Wakanui silt loam, shallow phase		200
Lismore-Wakanui complex		160
Kaiapoi silt loam		40
Morven silt loam		810
	Total	6,350
Class 4 - Restricted Suitability for Irrigation		
(a) Well drained to moderately well drained:		
Lismore stony sandy loam		1,540
Eyre Templeton complex		570
Steward stony sandy loam		970
Waimakariri stony sandy loam		360
(b) Imperfectly and Poorly Drained:		
Lismore-Waimairi complex		80
Temuka Silt loan		240
	Total	3,760
	Grand Total	12,370

Class 1

Eminently suitable for irrigation. Soils are deep, medium textured and well drained; available moisture is high. Topography is even and slopes are gentle. These soils are capable of producing high yields of a wide range of crops.

Class 2

Suitable for irrigation. Soils are less suitable than Class 1 owing to moderate depth, moderate drainage, moderately slow permeability in the subsoil, medium to high available moisture, or undulating topography.

Class 3

Of slightly restricted suitability for irrigation owing to shallowness of soil, stoniness, slow permeability in the subsoil, poor drainage, low to medium available moisture, or unfavourable topography.

These have been subdivided into Class 3a soils which are well drained or moderately well drained and Class 3b soils which are imperfectly drained.

Class 4

Of restricted suitability for irrigation owing to severe limitations in depth of soil, stoniness, permeability, drainage, available moisture, or topography. Except in special circumstances irrigation of this class is restricted to relatively permanent crop such as pastures and orchards.

These soils have been subdivided into Class 4a soils which are well drained or moderately well drained, and Class 4b soils which are poorly drained.

Source: Griffiths (1971)

Over 85 per cent of the scheme falls within soils of irrigability classes 3 and 4, which have restricted suitability for irrigation. For this reason, livestock breeding and fattening is the predominant land use pattern, with cropping being restricted to the small area of the heavier soils, classes 1 and 2.

In order to assess the impact of irrigation development in detail, it was necessary to collect farm level data through a sample interview survey of farmers within the scheme. The 13,000 ha and 64 farms were stratified into three types according to the irrigability class of their predominant soil type - the original Classes 1 and 2 of Griffiths (1971) were amalgamated since they represented a small proportion of the total area. Twenty farms were then randomly selected for interview survey, according to Table 28.

Table 28

Stratification of the Morven-Glenavy Farm Survey

Soil Class	Survey Type Classification	Total Area	Total No. of Farms	No. of Farms Surveyed
		ha		
1)) 2)	1	1887	15	4
3	2	6515	32	10
4	3	4669	17	6
		13,071	64	20

These survey farms in total covered 4562ha, or accounted for 35 per cent of total scheme area.

Data were collected in December 1978, and covered the period 1977-78. Comparison of survey results and aggregate farm data in Table 29 indicates the representative nature of the data collected. For instance, the total area of borderdyke development estimated from survey data is only 3 per cent less than the actual total developed.

Table 29

Comparison of 1978 Survey Results with Aggregate Farm Data

	Survey Results	Aggregate Data[b]
	ha	ha
Area borderdyked[a]	4287	4400
Area Spray Irrigated[a]	618	759
Average Farm Size:		
Survey Type 1	175	145
2	220	210
3	270	233

[a] Actual survey results adjusted by the scale factor of 2.87, derived from the areas of surveyed farms (4562 ha) compared with the total farm area (13,089 ha).

[b] Analysis of data supplied by J. Oliver, (pers. comm.).

On the basis of the survey data, modal (representative) farms were developed for each of the three farm types. The characteristcs of each of the types are detailed in Tables 30 and 31.

Table 30

Land Use Characteristics-Modal Farms 1977/78

Characteristics	Survey Farm Type 1	2	3
	ha	ha	ha
Total Area	121 (38)[a]	202 (85)	263 (65)
Land Use:			
Wheat	26 (2)		
Barley	10 (4)		
Peas	20 (8)		
Grasseed	8		
Clover	8 (4)		
Rape	8 (4)		
Total Crop	81 (22)	- -	- -
Pasture	40 (16)	202 (85)	263 (65)

[a] Figures in brackets denote area irrigated.

Table 31

Performance Characteristics - Modal Farms 1977/78

	Irrigated				Non Irrigated			
Crop Yields:	Farm Type	1	2	3	Farm Type	1	2	3
Wheat (t/ha)		5.4	-	-		4.6	-	-
Barley (t/ha)		5.1	-	-		4.3	-	-
Peas (t/ha)		3.8	-	-		3.1	-	-
Grass seed (kg/ha)		-	-	-		630	-	-
Clover Seed (kg/ha)		185	-	-		151	-	-
Oil Seed Rape (t/ha)		1.9	-	-		1.9	-	-
Stock Carrying Capacity (su/ha)			14.8				6.2	

Type 1 farms are predominately on the better soils of irrigability Classes 1 and 2, and cover 1887 ha or 14 per cent of the scheme area. On average, about 30 per cent of the farm is irrigated, the majority of which is spray irrigation of crops. The advent of irrigation has meant increased crop yields in addition to the ability to intensify crop rotations.

Type 2 and 3 farms are predominately grazing properties, varying only by soil type, size and borderdyke irrigation development. Although stock performance/capacity should reflect these differences, no significant variance was revealed by the survey and this has been confirmed by local M.A.F. personnel (J. Oliver, pers. comm). On average, for these two farm types, the advent of irrigation has generated the following major shifts:

1. Reduced use of specialist winter greenfeed resulting from a change to all-grass wintering.
2. Stock policy changes - from a 2 year ewe flock to Breeding Own Replacements.
3. Higher carrying capacity on irrigated pasture.

It can be noted here that rather than being used as an insurance measure in a dryland situation, irrigation should entail a major change in the system of farming and in the attitudes of farmers. This is perhaps best illustrated by the fact that 30 per cent of the farms on the scheme have changed hands since the scheme was voted in. The availability of irrigation has consequently generated the potential for significant changes in the farming pattern of the area. Removal of the soil-moisture restriction as a constraint to plant growth means the possibility of increased production from existing land use and/or diversification into new land use possibilities.

On farms of Type 2 and 3, there is no cropping of significance. Under the dryland regime prior to 1974, carrying capacity was up to almost 7 s.u/h.a with farmers operating a two year ewe policy and Corriedales being the predominant breed. There was a five year rotation out of old grass through winter greenfeed to new grass, and it is generally considered by the farmers and M.A.F. personnel that production was at capacity or even somewhat over-extended on average. This corresponds with the assumption made in Chapter 3 that no appreciable increase in production would have been likely under the 'without' irrigation situation.

The advent of irrigation has allowed increased carrying capacity and a change to all-grass wintering systems. Irrigated pastures now carry between 14 and 17 su/ha, under a Romney/Coopworth flock and breeding own replacements. Stock performance in general has either remained static or fallen slightly and lies in the range of 85-120 per cent lambing and 3.5 - 5.5 kg wool per head, but should increase as stock numbers stabilise. During the development phase, there would seem to be a trade-off between stocking rate and stock performance. To date, attention has been focussed predominantly on increasing the former, partly at the expense of the latter.

Gross farm revenues under a dryland situation 'without' irrigation and under the current situation 'with' irrigation were estimated for each of the three farm types for the 1977/78 year. These estimates were obtained by combining the land use characteristics, shown in Table 30, and the performance characteristics, shown in Table 31, with a set of representative prices for 1977/78 shown in Table 32 below. The increase in gross farm revenue resulting from the irrigation was, therefore, quantified simply in terms of the higher crop yields and stocking rates shown by the survey data.

Table 32

Representative Prices 1977/78

Crop/Livestock	Price ($)
Wheat	120 per tonne
Barley	100 " "
Peas	140 " "
Grass Seed	0.45 " kg
Clover Seed	1.40 " kg
Oil Seed Rape	230 " tonne
Sheep (gross revenue)	20 " ewe

The gross revenue for sheep was estimated on a per ewe basis and the number of ewes for each farm type was estimated, using the survey data, at 85 per cent of the total number of stock units carried. Production parameters used in the estimation of the gross revenue per ewe were; lambing 100 per cent, deaths 5 per cent, culls 5 per cent, and ewe and hogget clips both 4kg per head. The effective stocking area for farm type 1 was assumed to be 80ha.

Table 33

Dryland (without irrigation) Situation
- Morven-Glenavy Scheme 1977/78

	Gross Revenue per Farm ($)		
Crop/Livestock Farm Type	1	2	3
Wheat	14,400	-	-
Barley	4,400	-	-
Peas	8,750	-	-
Grass Seed	2,300	-	-
Clover Seed	1,700	-	-
Oil Seed Rape	3,500	-	-
Sheep	8,500	21,200	27,600
	43,550	21,200	27,600

Table 34

Current (with irrigation) Situation
- Morven-Glenavy Scheme 1977/78

Crop/Livestock	Gross Revenue per Farm ($) Farm Type 1	2	3
Wheat	14,600	-	-
Barley	4,650	-	-
Peas	9,600	-	-
Grass Seed	2,300	-	-
Clover Seed	1,900	-	-
Oil Seed Rape	3,600	-	-
Sheep	10,800	35,000	37,000
	47,450	35,000	37,000

The current and dryland situations for the Morven-Glenavy Scheme as a whole are compared in Table 35. Gross revenue per farm type has been estimated by multiplying the gross revenue per farm by the number of farms in each farm type.

Table 35

Comparison of Current and Dryland Situations
- Morven-Glenavy Scheme 1977/78

Farm Type	Number of Farms	Gross Revenue per Farm Type ($)		
		Dryland Situation	Current Situation	Difference due to irrigation
1	15	653,250	711,750	58,500
2	32	678,400	1,120,000	441,600
3	17	469,200	629,000	159,800
Totals	64	1,800,850	2,460,750	659,900

2. The Lower Waitaki Survey

The survey of farms on the Lower Waitaki Irrigation Scheme was undertaken by the M.A.F. in November 1978. Data were collected for the period 1973-78. Those data used in the present study to estimate gross farm revenues for the 1977/78 year in the 'with' and 'without' irrigation situations are outlined below. The method of estimating the difference in gross farm revenue attributable to irrigation is based on aggregate data for the whole scheme, and, as with the Morven-Glenavy data, aims simply to quantify the higher crop yields and stocking rates achieved with irrigation under the existing farming pattern. This method produces only an approximate estimate of additional gross farm revenue, but is sufficient for the purpose of the present study.

The product prices used to estimate the gross farm revenues are the same as those used for the Morven-Glenavy estimates, with the addition of;

	($)
Linseed	180 per tonne
Oats	85 per tonne

Aggregate data pertaining to the Lower Waitaki scheme are shown in Table 36.

Table 36

Aggregate Data - Lower Waitaki Scheme 1977/78

	(ha)
Total area	16,500
Border-dyke irrigation	7,940
Spray irrigation	2,410
Total irrigation	10,350
Area of crops	3,430
Stocking hectares	14,880

Land use and performance characteristics relating to the area cropped were also used in aggregate form[32]. The current stock carrying capacity was estimated at 12.7 s.u./h.a., whereas under the dryland situation it was estimated to be 6.2 s.u./h.a. On the better pastures the potential stocking rate with irrigation was estimated to be as high as 18 s.u./h.a.

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[32] The area and yields of crops are shown in Table 37. Seventy per cent of the crop area is estimated to be spray irrigated.

Table 37

Area and Crop Yields - Lower Waitaki Scheme 1977/78

Crop	Yield Non-Irrigated	Yield Irrigated	Area (ha)
Wheat (t/ha)	4.0	4.0	840
Barley (t/ha)	3.8	3.9	730
Oats (t/ha)	3.6	4.6	220
Peas (t/ha)	2.6	3.0	670
Grass seed (kg/ha)	764	921	220
Clover seed (kg/ha)	243	283	300
Oil seed Rape (t/ha)	1.1	2.0	20
Linseed (t/ha)	2.0	2.7	430

Using these data, a comparison of the current and dryland situations is given in Table 38.

Table 38

Comparison of Current and Dryland Situations - Lower Waitaki Scheme 1977/78

	Gross Revenue of All Farms ($)		
	Dryland Situation	Current Situation	Difference due to Irrigation
Crops	1,329,400	1,483,600	154,200
Sheep	1,568,400	3,212,600	1,644,200
Totals	2,897,800	4,696,200	1,798,400

APPENDIX 3

Industry Classification : 70 Industries

Industry Number	
1.	Agricultural and Livestock Production
2.	Agricultural Services
3.	Hunting, Trapping & Game Propagation
4.	Forestry
5.	Logging
6.	Fishing
7.	Coal Mining
8.	Crude Petroleum & Natural Gas Production/Metal Ore Mining.
9.	Other Mining
10.	Food Manufacturing
11.	Beverage Industries
12.	Tobacco Manufactures
13.	Manufacture of Textiles
14.	Manufacture of Wearing Apparel, Except Footwear
15.	Manufacture of Leather & Products, Leather Substitutes and Fur except Footwear and Wearing Apparel
16.	Manufacture of Footwear except Rubber or Plastic Footwear
17.	Wood and Wood and Cork Products including Furniture
18.	Furniture and Fixtures except primarily of Metal
19.	Paper and Paper Products
20.	Printing, Publishing and Allied Industries
21.	Industrial Chemicals
22.	Other Chemical Products
23.	Petroleum Refineries/Manufacture of Miscellaneous Products of Petroleum and Coal
24.	Manufacture of Rubber Products
25.	Manufacture of Plastic Products n.e.c.
26.	Pottery, China Earthenware
27.	Glass and Glass Products
28.	Other non-metallic Mineral Products
29.	Iron and Steel Basic Industries
30.	Non Ferrous Metal Basic Industries
31.	Fabricated Metal Products
32.	Machinery Except Electrical
33.	Electrical Machinery Apparatus, Appliances, and Supplies
34.	Transport Equipment
35.	Professional, Scientific, Measuring Equipment and Photo and Optical Goods.
36.	Other Manufacturing Industries
37.	Electricity, Gas and Steam
38.	Waterworks and Supply
39.	Construction
40.	Wholesale Trade
41.	Marketing Boards etc.
42.	Retail Trade
43.	Restaurants, Cafes and Other Eating and Drinking Places
44.	Hotels, Rooming Houses, Camps and Other Lodging Places
45.	Land Transport

46. Water Transport
47. Air Transport
48. Services Allied to Transport
49. Communication
50. Financial Institutions
51. Insurance
52. Real Estate
53. Business Services Except Machinery and Equipment, Rental and Leasing
54. Machinery and Equipment Rental and Leasing
55. Public Administration and Defence
56. Sanitary and Similar Services
57. Education
58. Research and Scientific Institutes
59. Medical, Dental, Other Health and Vet. Services
60. Welfare Institutions
61. Business, Professional and Labour Associations
62. Other Social and Related Community Services
63. Motion Picture and Other Entertainment Services
64. Libraries, Museums, Botanical and Zoological Gardens etc.
65. Amusement and Recreational Services n.e.c.
66. Repair Services n.e.c.
67. Laundries, Cleaning and Dyeing Plants
68. Domestic Services
69. Miscellaneous Personal Services
70. International and Other Extra-Territorial Bodies
71. Activities Not Adequately Defined

n.e.c. - not elsewhere classified

Source: Census of Population and Dwellings 1971, Department of Statistics

APPENDIX 4

Industry Classification : 12 and 9 Industries (Department of Labour)

Industry
Number

Prior to 1971

1. Forestry, logging, mining, quarrying
2. Food, drink, tobacco
3. Textiles, clothing, leather
4. Building materials
5. Engineering and metal work
6. Miscellaneous manufacturing
7. Power, water and sanitary
8. Building and construction
9. Transport and communications
10. Commerce
11. Domestic and personal
12. Adminstration and professional

Since 1971

1. Forestry and logging
2. Mining and quarrying
3. Manufacturing
4. Electricity, gas and water
5. Construction
6. Wholesale, retail, restaurants and hotels
7. Transport, storage and communications
8. Finance, insurance, real estate and business services
9. Community and personal services

Source: Dept of Labour, Wellington

APPENDIX 5

Industry Classification

12 Industries: (Department of Statistics)

Industry Number

1. Farming, Hunting and Fishing
2. Forestry and Logging
3. Mining and Quarrying
4. Food Products Manufacturing
5. Other Manufacturing
6. Electricity, Gas and Water
7. Construction
8. Wholesale and Retail Trade, Restaurants and Hotels
9. Transport, Storage, Communication
10. Insurance, Real Estate, Finance
11. Public Administration
12. Social, Personal and Community Services

Source: Inter-Industry Study of the NZ Economy 1971-72 (12 sector model), Dept of Statistics.

APPENDIX 6

Employment and Location Quotients : Keynesian Model

Industry Group	Employment (1971)		Location Quotient
	Waimate and Waitaki Counties	New Zealand	
1	2,633	121,841	2.26
2	22	7,053	.33
3	25	5,265	.50
4	1,072	59,959	1.87
5	872	221,151	.41
6	240	13,273	1.89
7	1,021	93,688	1.14
8	1,930	198,315	1.02
9	843	103,181	.86
10	328	64,744	.53
11	236	53,358	.46
12	1,400	162,413	.90
	57	14,564	
	10,679	1,118,835	

Source : Census of Population and Dwellings 1971, Department of Statistics.

APPENDIX 7

Input-Output25 Sector Classification

Industry Number	
1.	Agriculture
2.	Fishing and Hunting
3.	Forestry and Logging
4.	Mining and Quarrying
5.	Food, Beverages and Tobacco
6.	Textile, Apparel and Leather Products
7.	Wood and Wood Products
8.	Paper, Printing and Publishing
9.	Chemical, Petrol and Plastic Products
10.	Non-Metallic Mineral Products
11.	Basic Metal Industries
12.	Metal Products and Machinery
13.	Other Manufacturing
14.	Electricity, Gas and Water
15.	Construction
16.	Wholesale and Retail Trade, Restaurants and Hotels
17.	Transport and Storage
18.	Communications
19.	Insurance, Real Estate and Finance
20.	Ownership of Dwellings
21.	Social, Personal and Community Services

Industry Number	
22.	Central Government
23.	Local Government
24.	Private Non-Profit Services to Households
25.	Domestic Services

Source: Inter-Industry Study of the NZ Economy 1971-72 (25 sector model), Department of Statistics

APPENDIX 8

Employment and Location Quotients:Input-Output Model

Sector Number	Census Code	Employment (1971) Otago	Employment (1971) New Zealand	Location Quotient
1	001-059	7,393	118,200	1.01
2	060-069 and 090-109	454	3,641	2.02
3	070-089	372	7,053	.86
4	110-127	237	5,265	.73
5	130-192	4,957	65,207	1.23
6	193-240	3,991	50,898	1.27
7	241-259	827	20,897	.64
8	260-274	1,366	28,349	.78
9	275-310	651	23,140	.46
10	315-329	545	10,694	.83
11	330-331	238	4,078	.95
12	335-401	3,661	73,845	.80
13	402-409	117	4,002	.47
14	410-421	1,093	13,273	1.34
15	422-449	5,752	93,688	1.00
16	450-579	12,639	198,315	1.03
17	580-644	4,707	73,816	1.03
18	645	1,693	29,365	.94
19	650-705	3,331	64,774	.83
20	-	-	-	[a]
21	710-899 (excl. those in 22-25	11,548	156,683	1.20
22	710-719 and 890-899	1,834	47,207	.63
23	820-829	114	1,521	1.22
24	780-790	431	6,531	1.07
25	870	314	4,585	1.11
		689	13,808[b]	
		68,955	1,118,835	

[a] Ownership of Dwellings sector - location quotient assumed to be 1.0.

[b] Employment not adequately defined.

Source: Census of Population and Dwellings 1971, Department of Statistics.

APPENDIX 9

Price Indices
(1971 = 100)

Year	Agriculture[a]	Construction[b]	
1970/71	96	85)	95[c]
1971/72	100	100)	
1972/73	118	110	
1973/74	167	116	
1974/75	149	129	
1975/76	135	157	
1976/77	182	192	
1977/78	203	220	

[a] Prices for agricultural output derived from New Zealand Yearbook data.

[b] Derived from M.W.D. construction cost index.

[c] 95 used because two-thirds of expenditure undertaken in 1971/72 (see Table 10).

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