A STUDY OF EXCESS LIVESTOCK TRANSPORT COSTS IN THE SOUTH ISLAND OF NEW ZEALAND

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PREFACE

This study should be seen as a contribution to the Agricultural Economics Research Unit's research efforts aimed at holding or reducing marketing costs for major agricultural export products.

The feature of livestock passing the nearest freezing works for slaughter, so incurring excessive transport costs, has drawn considerable comment over the past few years. The study reported here attempts to place these excess transport costs for South Island livestock in perspective, with respect to both explanations for their occurrence and their significance in dollar terms.

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SUMMARY

This study provides a measure of the "excessive" costs of assembling sheep and lambs for slaughter at South Island freezing works. The results show that for a representative season approximately 25 per cent of the transport costs could be considered as excessive, i.e. stock are shipped beyond their nearest works.

The excess transport cost due to the seasonality of production was also estimated and found to be a relatively small component of these costs. This estimate however was considered to be conservative.

The model used in this study has made it possible to evaluate the effects on total transport cost, of marginal changes in freezing works capacities, regional livestock supplies, and the holding of livestock on farms during peak periods. This type of information could be a valuable guide to any long run structural changes in the industry.

CHAPTER 1

INTRODUCTION

Marketing costs for New Zealand meat exports have risen sharply in the recent past, creating considerable apprehension for the industry's prospects. For example, total costs for lamb, mutton and beef from farm gate to f.o.b. have risen 34 per cent in the two year period ending January 31, 1979.[1] One component of these total costs is the cost of moving livestock from the farm gate to the freezing works. In circumstances where livestock are transported beyond the nearest processing or freezing works, these total collection costs may be considered higher than necessary.

This paper develops a methodology for estimating the extent of aggregate collection costs arising from works bypassing. The term 'excess transport' hereafter refers to transport movements of livestock beyond the nearest freezing works. Attention is directed at one particular cause of excess transport and the implications of marginal changes in livestock supply and works' capacity on total collection costs, are also evaluated.

1.1 The Economic Problem

It has been reported that average distances travelled by sheep and lambs to New Zealand freezing works in the 1974/75 season were 135.35 km and 120.64 km respectively.[2] These estimates far exceeded the 'representative distances' of 50 km used for illustrative

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[1] N.Z. Meat Producers Board "The N.Z. Meat Producer", Vol 7 No.4, Jan 1979, p.2.

[2] P.D.Chudleigh, M. Clemes & L.D.Woods "Marketing Costs for New Zealand Meat Exports 1970/71 to 1975/76". Research Report No. 94, Agricultural Economics Research Unit, Lincoln College, 1978, p.56.

purposes by the New Zealand Meat Producers' Board. Combining the former estimates with average transport costs for 1975/76 found in the same report and 1975/76 throughputs of lamb and sheep, yielded a combined total transport (farm gate to freezing works) bill for New Zealand of $16.1 million for the 1975/76 season. A portion of this bill is possibly attributable to inefficient assembly of livestock throughout the country.

There are a number of reasons explaining why livestock may be transported beyond the nearest freezing works. Five of the principal reasons are:

1. Lack of capacity at local freezing works in certain months due to a seasonal demand for killing space.

2. The existence of traditional supply links between specific farms and freezing works.

3. Freezing works operating below efficient throughput levels may pay long distance transport costs to obtain supplies or specific export contracts may warrant a similar search for livestock when local supplies are inadequate.

4. Industrial stoppages, mechanical failure, etc. at the nearest works may lead to shutdown of works or reductions in throughput.

5. Companies with more than one freezing works often schedule openings and closings of works and livestock movements to minimize total costs of all works in the company.

Of the five reasons listed above, only the first, which concerns the seasonality of supplies, can be easily isolated and quantified without a detailed survey of individual works. The average distance of livestock movements during the period when supplies are most concentrated could be shortened as a result of early slaughter or by the withholding of livestock in order to utilise local facilities in the subsequent, uncongested period. Presently, however, there is little incentive for suppliers to alter existing supply patterns and, hence, reduce the amount of excess livestock transport. This observation follows from the relationships between transport and killing costs and Schedule Prices which are discussed below.

1.2 The Schedule Pricing System

Most livestock bound for export markets are purchased from individual farmers by meat exporting companies. Suppliers receive payment in the form of a Schedule Price less a transport charge which is the cost of transporting supplies from the individual farm to the nearest port works (NPW).[3]

Schedule Prices are set for each week by a conference of the meat export companies and the New Zealand Meat Producers' Board and are accepted by the industry as a national base. Price determination is based on anticipated prices per kg in the final markets for each product with fixed and variable costs incurred beyond the farm gate deducted from this weighted average. Included in the costs are killing and other fixed charges as well as any operating costs such as collection costs that are necessary to secure supplies.

In many instances the NPW transport charge (paid by farmers) is a poor reflection of costs incurred by freezing works to secure desired supplies. For example, if livestock travel to the NPW for slaughter, actual transport expense will equal the NPW charge. But when

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[3] Seven freezing works in the South Island are designated as port works owing to their proximity to shipping facilities.

livestock are sent to a more distant works, the farmer's liability for transport expenses is conventionally limited to the NPW charge and the buyer is responsible for any excess cartage costs. On the other hand, where the NPW charge exceeds actual costs the meat export company will use the surplus to offset carrying costs of finished product, for example from an inland works to a shipping port.

Collection costs are complicated to analyse not only when suppliers send livestock to a works other than the NPW but whenever the latter is neither the nearest freezing works nor near facilities for export shipping. For example, at present there are seven NPW's in the South Island but meat exports are shipped largely from only three ports. The inevitable result is one of allocative inefficiency; the NPW charge does not encourage a minimisation of excess transport because farmers are charged a fixed amount regardless of actual costs. Export meat companies (and freezing works on their own account) also appear to have no direct incentive in lowering average collection costs as long as excess cartage costs can be recovered via higher operating costs which result in lower Schedule prices.

1.3 Excess Transport and Killing Charges

In the preceding section it was implied that farmers ultimately bear excess transport costs. The NPW charge, moreover, tends to obscure the advantage to farmers of avoiding livestock transport beyond the nearest works.

Schedule Prices are influenced in two separate ways by excess transport costs. First, 'normal' operating costs of individual works have grown to include allowance for much excess cartage - leading to higher killing charges and lower Schedule Prices. Second, specific export contracts often necessitate higher collection costs over a short period and these transport costs are paid, generally, by the meat export company; inasmuch as they are considered an unavoidable business expense they are eligible to be deducted (at an early stage) from Schedule Prices.

A number of reasons exist to support the belief that excess transport costs may be considerable. The magnitude of this category of costs, nevertheless, is difficult to determine with the present allocation of transport charges. A reduction in excess transport may not alter immediately the transport charge paid by suppliers, or raise farm gate returns, but potentially could lower operating costs of works and ultimately raise Schedule Prices.

CHAPTER 2

PREVIOUS STUDIES

There has been little research concerning assembly costs of livestock and the composition of the total transport bill. Several reports, however, have looked at the general desirability of less reliance on a concentrated kill in the meat export industry. For example, in 1969 the Spread of Livestock Kill Committee of the Agricultural Production Council - representing producer, industry and government bodies - recommended further study of "how best financial incentives might be given to bring about an improved spread of kill either earlier or later and between different classes of stock".[4]

Herlihy (1970) argued that spreading the kill, from the farmer's point of view, was beneficial and "technically feasible" yet he offered no estimate of savings at transport or processing stages.[5] In general, emphasis was placed on implications for farm management rather than on marketing costs beyond the farm gate.

In 1974 another study reported the construction of a model to optimise location and size of present and potential freezing works in the South Island (Brodie & McCarthy 1974). Taken into consideration were annual assembly, processing and distribution costs from farm gate to port. Some data relating to length of transport distances were reported and are reproduced in Tables 1 and 2.

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4 Agricultural Production Council (1970), "Report of Spread of Kill Sub Committee of the Meat Committee", unpublished, Wellington, pp 14-15.

5 G.J. Herlihy (1970), "The Spread of Lamb and Mutton Kill in Southland from the Producer Viewpoint", Master of Agricultural Science Thesis, University of Canterbury, p 69.

These data indicate that the bulk of sheep and lambs are slaughtered in the region of supply and also that a stable proportion of total supplies are slaughtered beyond the nearest works.

The report concluded that instead of the then existing 15 works, only 6 were necessary. Essentially, the report dealt with long-run issues and ignored other policy considerations including the costs and benefits of seasonal supplies and excess transport owing to seasonality.

The impact of seasonality on excess transport was not a primary area of study in the above reports. However, it was suggested that reductions in peak supplies could produce benefits at various stages of meat processing. Estimation of transport cost savings from reducing seasonality, therefore, remains to be analysed in detail.

TABLE 1

Inter-Provincial Movement of Livestock Killing Supplies

Killing Province		Supply Province: Nelson	Marl-borough	West Coast	Canter-bury	Otago	South-land	% Total
a) 1970-71 Season								
Nelson	Lamb	99.0	1.0					100
	Sheep	100.0						100
Marlborough	L	1.5	98.5					100
	S	3.6	96.4					100
Canterbury	L		2.3	2.3	88.8	6.6	0.1	100
	S		1.4	2.7	85.5	8.4	2.0	100
Otago	L				11.1	83.7	5.2	100
	S				10.3	81.8	7.9	100
Southland	L				2.6	13.5	83.9	100
	S					9.3	80.7	100
b) 1971-72 Season								
Nelson	L	96.8	3.2					100
	S	98.8	0.2					100
Marlborough	L	0.2	97.5	1.2	1.1			100
	S	0.1	94.9	0.6	4.4			100
Canterbury	L		1.8	2.2	90.0	6.0		100
	S		2.2	3.7	89.5	7.2	0.4	100
Otago	L				9.6	85.3	5.1	100
	S				14.6	74.3	11.1	100
Southland	L				0.2	13.0	86.8	100
	S					13.3	86.7	100

Source: R.J.Brodie and W.O.McCarthy (1974), "Optimum Size, Number and Location of Freezing Works in the South Island, New Zealand - A Spatial Analysis", Market Research Report No. 7, Agricultural Economics Research Unit, Lincoln College, p 47.

TABLE 2

Sheep and Lamb Movements for Slaughter

Season	Total Kill (10^6LE)[d]	% Normal Haul[a]	% Medium Haul[b]	% Long Haul[c]	% Total
1967-68	16.5	89.1	9.5	1.4	100
1968-69	17.0	88.5	9.5	2.0	100
1969-70	16.8	88.2	10.0	1.8	100
1970-71	17.3	87.2	10.2	2.6	100
1971-72	17.7	88.4	9.4	2.2	100

[a] Normal Haul was defined as movement to the closest works.

[b] Medium Haul was defined as movement to a works within approximately 100 miles of the nearest works.

[c] Long Haul was defined as all other movements.

[d] LE = Lamb equivalents

Source: R.J. Brodie and W.O. McCarthy (1974), "Optimum Size, Number and Location of Freezing Works in the South Island, New Zealand - A Spatial Analysis", Market Research Report No.7, Agricultural Economics Research Unit, Lincoln College, p 47.

CHAPTER 3

METHODOLOGY AND DATA

3.1 Objectives

Five main reasons for excess transport were listed previously. The first related to transport flows caused by seasonality of supplies whereas the others are linked with institutional factors. The major objective of the current study is to derive an estimate of excess transport costs of lamb and sheep in the South Island for a representative year and from this estimate ascertain the proportion due to seasonality.

The method used is to construct a linear programming (LP) model that could generate two scenarios of transport flows and their respective total costs. Both scenarios have two time periods: a congested peak supply period and an off-peak period.

The first scenario stipulates that supplies are to be slaughtered and processed at the nearest freezing works. Thus, where supplies exceed local works' capacities the assumption is that livestock would be held on the farms until local capacity becomes available. This situation is simulated in the LP model by assuming that holding stock on farms has an extremely low cost.

The second scenario considered is one where slaughter must occur in the period when supply becomes available. To simulate this situation in the model, withholding costs are set at a prohibitively high level so that the cost of transporting supplies to any distant freezing works is always less than the withholding cost. Given farmers' demands to have their livestock killed as soon as they reach prime condition (usually in the peak), Scenario 2 is a realistic simulation of transport flows that result from the existing seasonality of processing.

The two scenarios outlined above give different collection cost totals. These amounts vary because of the assumptions regarding the flexibility of shifting processing between two periods: an 'instant' kill meant that little or no flexibility existed and the reverse was true for a 'spread' kill. Consequently, considerable importance is attached to the holding cost that controls the transfer of peak supplies for off-peak slaughter. Withholding occurs when supplies intended for slaughter in the peak are killed in the previous period or held throughout the peak period.

The two estimates of total collection costs derived from the model are compared with an estimate of actual costs calculated from an independent source. The difference between the solution with minimal holding costs, i.e. Scenario 1, and the estimate of actual transport costs is defined as the excess transport bill. Next, the difference between Scenario 1 and the situation where holding costs are prohibitively high (i.e. Scenario 2) is defined as the component of excess transport costs due to seasonality of supply.

FIGURE 1

Cost Relationships Between Scenarios

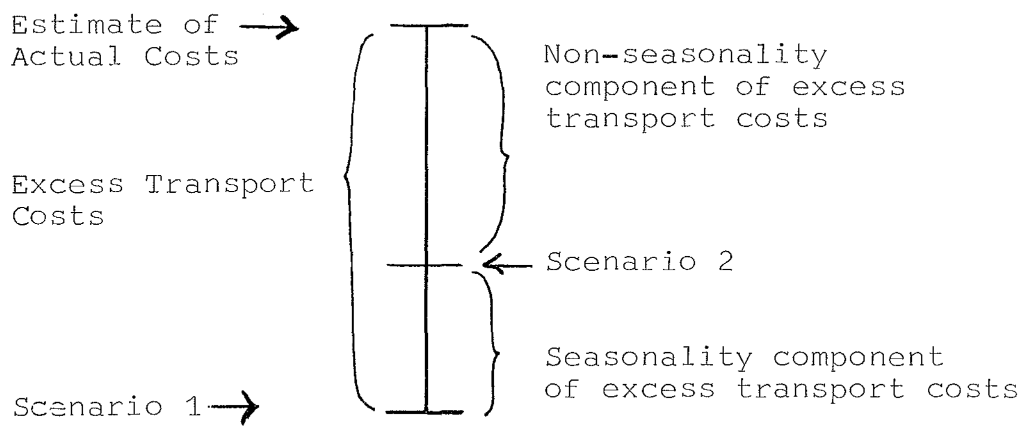

Figure 1 depicts the relationship between the various costs which are of interest. The category of costs labelled "non-seasonality component of excess transport costs" is a residual which results from the subtraction of the total transport cost of Scenario 2 from the estimate of actual costs.

3.2 A Description of the Model

Linear programming (LP) models can identify least cost solutions for assigning flows of goods or services from a number of origins to a number of destinations, given various supply and demand constraints, costs of flows, etc.

In the simplest LP transport model there is only one time period when all supplies are transported; any demand or capacity constraints are confined to the single period. The objective function of the general linear model is usually to minimise total transport costs by assigning units of the good to flow from specific origins to specific destinations. Using conventional mathematical terms the general model is defined as:

$$\text{Minimise } TC = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$$

where $i = 1, 2...m$ and m is the number of supply centres and $j = 1, 2...n$ and n is the number of demand centres.

Subject to the constraints

$$\sum_{j=1}^{n} X_{ij} = S_i$$

$$\sum_{i=1}^{m} X_{ij} = D_j$$

$$\sum_{i=1}^{m} S_i = \sum_{j=1}^{n} D_j$$

$$X_{ij} \geq 0$$

where TC = total transport costs

C_{ij} = unit cost of transport from origin i to destination j

S_i = quantity supplied at origin i

D_j = quantity demanded at destination j

X_{ij} = non-negative number of product units shipped from origin i to destination j that minimises the objective function.

This specification is impractical when fluctuations of supply or demand impose constraints on X_{ij} within the single period model.

Two modifications are made to the general transport model to facilitate examination of the seasonality issue of lamb and sheep flows in the South Island. Firstly, flows from all origins to all destinations are possible in two periods, peak and off-peak. In the peak period supplies often can exceed capacity available at nearest freezing works while in the off-peak there are virtually no capacity constraints. Secondly, a new pseudo transport activity with an associated cost is introduced. This activity, known as holding, acts to direct peak surplus supplies to the off-peak. From the farmer's point of view this would be accomplished when livestock normally destined to be slaughtered in the peak are slaughtered in a prior period or withheld throughout the peak for later off-peak slaughter.

Holding costs can be varied to reflect different and extreme industry attitudes to the desirability of withholding stock from slaughter. No attempt is made to select a single value which is representative of real farm costs. Clearly, this would require knowledge of regional grazing characteristics, expectations of Schedule Prices through the season, etc.

The specification of the revised model is as follows:

$$\text{Minimise TC} = \sum_i \sum_j C_{ij} X_{ij} + \sum_i A_i H_i + \sum_i \sum_j C_{ij} XX_{ij}$$

where $i = 1, 2 \ldots 32$
$j = 1, 2 \ldots 8$

Subject to the constraints

$$\sum_j X_{ij} = S_i - H_i$$

$$\sum_i X_{ij} \leqslant D_j$$

$$\sum_j XX_{ij} = SS_i + H_i$$

$$\sum_i XX_{ij} \leqslant DD_j$$

$$\sum_i S_i + \sum_i SS_i \leqslant \sum_j D_j + \sum_j DD_j$$

$$X_{ij},\ H_i,\ XX_{ij} \geqslant 0$$

where TC = total transport and holding costs

C_{ij} = unit transport costs from origin i to destination j

H_i = quantities directed from peak supplies to off-peak flows

A_i = cost per unit of H_i

X_{ij} and XX_{ij} = numbers of units transported in the peak and off-peak, respectively, to minimise TC

S_i and SS_i = original peak and off-peak supplies respectively

D_j and DD_{jj} = effective capacities of freezing works in the two periods respectively.

3.3 Data Requirements

Before discussing data utilised in the model two assumptions require elaboration. The first concerns the choice of product unit and the second considers the choice of time periods.

Owing to the importance of sheepmeat in the export meat industry and the seasonality of slaughter of lambs and sheep, the unit used in the model is thousands of lamb equivalents (LE), where 1 sheep is equal to 1.25 lambs.[6] Slaughter statistics are mainly tabulated in LE because processing techniques and equipment are interchangeable between lambs and adult sheep. Similarly, transport facilities are compatible for all types of sheep. Recognition is given to the fact that adult sheep require more handling and more space than lambs by means of this widely used proportionality factor.

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[6] This ratio (1.25:1) is used by the New Zealand Meat Producers Board. Transport rates for regional carriers imply a similar but not identical ratio between sheep and lamb transport costs.

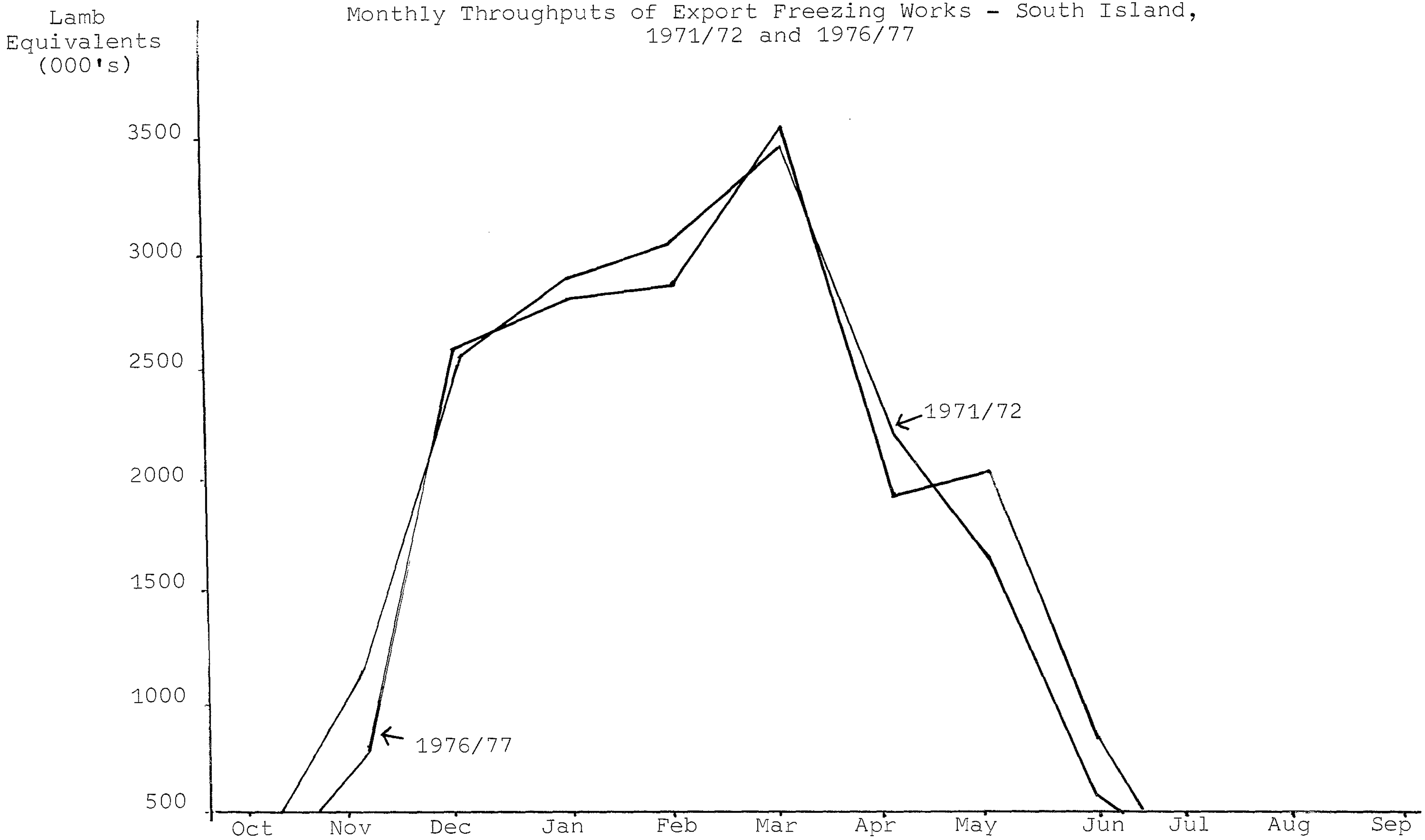
Selection of a suitable peak period was complicated in that lambs and sheep have different peak supply months and regions in the South Island experience slaughter congestion at different times in a season, e.g. the lamb peak period commences earlier in Canterbury Province than in Southland. Nevertheless for the South Island in aggregate the three months of heaviest LE slaughter in 1976/77 were January, February and March. Figure 2 indicates that peaks in LE slaughter have changed little for the two seasons considered. Historical evidence, such as monthly slaughter totals compiled by the N.Z. Meat Producers Board, suggest that the ratio of peak to off-peak processing has remained stable over time. Thus, January, February and March were defined as the peak and the nine proceeding months constituted the off-peak for the season.

Details of the other assumptions and data sources follow under appropriate headings:

3.3.1 Origins and Supplies. A 1975 Survey of South Island farmers served as the basis for geographical origins and supply estimates (Young et al., 1978). Results of this survey contained monthly data of lamb and sheep transport to freezing works from farms in 32 counties (or small county clusters). Hence, monthly slaughter statistics for the 1974/75 season could be apportioned to the county of origin. Table 3 displays the relative county weights of peak and off-peak supplies which subsequently were applied to the 1976/77 total of LE slaughter to create regional supplies. The reason for using the 1976/77 statistic was that this was the most recent available.

FIGURE 2

Monthly Throughputs of Export Freezing Works - South Island, 1971/72 and 1976/77



Source: New Zealand Meat Producer's Report, 1972 and 1978 Annual Reports, respectively.

TABLE 3

Survey Proportions of Supply for
Freezing Works within Slaughtering Regions
(South Island Regions)

Region	Peak (000's Lamb	Off-Peak Equivalents)	Peak (% of South	Off-Peak Island Total)
1 Marlborough	13	13	.75	.75
2 Awatere	7	12	.40	.69
3 Kaikoura	9	4	.52	.23
4 Golden Bay,Waimea	12	11	.69	.63
5 Buller,Inanguhua	6	4	.35	.23
6 Westland	4	3	.23	.17
7 Amuri	16	14	.92	.81
8 Cheviot	8	7	.46	.40
9 Waipara	18	25	1.04	1.44
10 Ashley	13	13	.75	.75
11 Rangiora	3	5	.17	.29
12 Eyre,Oxford	15	18	.86	1.04
13 Malvern,Tawera	25	31	1.44	1.78
14 4-Ch-Ch Counties	5	4	.29	.23
15 Akaroa,Waimea	8	4	.46	.23
16 Ellesmere	15	31	.86	1.78
17 Ashburton	48	42	2.76	2.42
18 Strathallan	35	41	2.01	2.36
19 MacKenzie	51	50	2.93	2.88
20 Waimate	55	48	3.16	2.76
21 Waitaki	47	39	2.70	2.24
22 Waihemo,Waikouaiti	23	12	1.32	.69
23 Dunedin Area	20	11	1.15	.63
24 Bruce	32	24	1.84	1.38
25 Clutha	86	73	4.95	4.20
26 Taupere	37	41	2.13	2.36
27 Mariatutu	47	18	2.70	1.04
28 Vincent	26	13	1.50	.75
29 Lake	11	10	.63	.58
30 North Southland	74	80	4.26	4.60
31 Invercargill	55	45	3.16	2.59
32 Wallace,Fiordland	90	79	5.18	4.54
	914	815	52.57	47.47

Source: Derived from Survey data in Young, S.L., Ambler, T.I., and Filan, S.J. (1978), "A Transport Survey of South Island Farmers", Research Report No. 90, Agricultural Economics Research Unit, Lincoln College.

3.3.1 (cont'd)

Implicit in the above procedure for estimating regional supplies is the assumption that what was transported from regions equalled the amount that farmers desired to slaughter. This is only strictly true for the season taken in its entirety; observed delays and works bypassing, therefore, would increase as the time period considered shortened. In a two period model such as this, some congestion and accompanying works bypassing will be overlooked because many delays and local capacity constraints are encountered within, rather than between, these periods. Hence, use of two time periods will bias the model results in favour of less works bypassing than actually occurs.

The Table 3 proportions had a sound statistical foundation obtained from a large mail survey of farmers (3,156 questionnaires sent with a response rate of 59.2 per cent). As a crude test of validity of the data, the following comparison was deemed satisfactory: the New Zealand Meat Producers' Board reported that LE slaughter in the 1975 peak in Canterbury and Northern South Island was 20.3 per cent of total slaughter - the Survey weighting for the same such population was 21.1 per cent.

One final caution remains in the application of the Survey weights to the 1976/77 season slaughter. If the relative county weights in 1976/77 and 1974/75 seasons were not approximately comparable, the reliability of the results would be in doubt. For instance, regional supplies may have expanded or contracted contrary to national trends since 1974/75.

Finally, the transport algorithm of linear programming requires point locations for each region.

This specification necessitated enumeration of a plausible livestock density centre on a major road for each of 32 regions.

3.3.2 Destinations and Capacities. The majority of freezing works in the South Island are situated near population centres. From a total of 15 freezing works only 8 demand centres were required (because of works concentrations) and a city or town acted as the centre for freezing works' capacity.

Monthly processing totals for 1976/77 for South Island works in aggregate were obtained from the most recent New Zealand Meat Producers' Board Annual Report (1978). Peak capacity was assumed to be equal to the calculated slaughter during January, February and March 1977. Off-peak capacity (i.e. for the remaining nine months of the season) was not related to actual throughputs; it was simply estimated at three times peak capacity.

Estimates of individual freezing works throughputs for killing seasons 1970/71 to 1976/77 are presented in Table 4. Average proportions for the total throughput during this period were calculated for individual works centres and used in the derivation of monthly slaughter capacities for each centre. Thus, if Works A contributed 5 per cent on average to throughputs from 1970/71 to 1976/77, then A was assumed to contribute 5 per cent to all monthly throughputs for a representative season. These average contributions and the effective capacities derived from them are not maximum limits of throughputs; rather, they are considered to be estimated realistic throughputs.

TABLE 4

Percentage of Total LE Throughputs - 1970/71 to 1976/77
By South Island Freezing Works

Demand Centre	Freezing Works	1970 -1971	1971 -1972	1972 -1973	1973 -1974	1974 -1975	1975 -1976	1976 -1977	Avg.
STO	Nelson	1.8	1.8	1.6	1.3	2.1	1.5	1.6	1.7
PIC	Picton	2.1	2.6	2.4	2.3	2.6	2.5	2.1	2.4
CHR	(Kaiapoi	3.6	3.7	3.8	3.7	2.7	3.8	3.9	3.6
	(Islington	5.5	6.2	6.4	5.8	5.9	6.4	5.7	6.0
	(Belfast	3.8	3.8	4.0	3.8	0	0	0	2.2
	(Canterbury	5.1	5.3	5.2	5.0	7.7	8.6	9.6	6.6
	(Fairton	5.3	5.9	6.2	5.8	6.8	7.1	6.7	6.3
S & P	(Smithfield	5.4	5.5	5.8	5.8	5.8	6.3	6.4	5.9
	(Pareora	6.8	6.2	6.9	7.4	6.3	7.9	7.3	7.0
PUK	Pukeuri	6.3	6.1	6.4	6.6	6.3	6.6	7.8	6.6
BUR	Burnside	6.6	5.9	5.8	5.8	6.0	6.3	5.1	5.9
BAL	Balclutha	8.7	8.7	8.7	8.5	8.5	9.0	7.4	8.5
I & B	(Ocean Beach	8.5	7.9	7.4	7.3	8.7	6.5	7.8	7.7
	(Mataura	8.3	7.9	7.8	7.8	8.2	7.7	8.4	8.0
	(Makarewa	9.7	10.0	9.5	10.4	10.8	9.2	8.7	9.8
	(Alliance	12.6	12.3	11.9	12.5	11.6	10.5	11.6	11.9

Sources: Derived from data in
P.D. Chudleigh, M. Clemes and L.D. Woods, "Marketing Costs for New Zealand Meat Exports 1970/71 to 1975/76", Research Report No. 94, Agricultural Economics Research Unit, Lincoln College, August 1978, pp 17 and 23;
South Island Freezing Works Association letters.

3.3.3 Transport Costs. With minor exceptions, livestock transport from farm gate to freezing works is by road. The rates of road carriers vary with livestock type, distance travelled and region of contract origin. Exact data for these charges are practically impossible to acquire but the Road Transport Association, representing road transport carriers, publishes recommended schedules of rates for South Island regions. Generally, these schedules guide actual rates; they include separate rates for adult sheep and lambs and they have a constant rate of increase up to approximately 160 km.

The present model employed schedule rates as of March 1978 for the largest province, Canterbury, and extrapolated estimates of rates for distances beyond 160 km. The use of other regional schedules was avoided for the following reasons:

1. Other schedule rates were approximately comparable to the Canterbury Schedule.
2. Some schedules did not quote rates up to 160 km.
3. Some regions advocate origin-based rates and others destination-based rates for inter-regional movements.

Therefore, a single rate was associated with the transport of one unit of LE from each supply centre to each destination. LE rates were calculated by taking 85 per cent of the lamb transport rate and 15 per cent of the adult sheep rate; the percentages reflect the relative weights of the livestock categories slaughtered.

3.3.4 Holding Costs. A principal objective of the project was to isolate the effect of seasonality on collection costs. Hence, it is important to simulate a situation where peak and off-peak supplies cannot be altered and, next, introduce the opportunity to decrease peak supplies. Holding costs perform the task of regulating the flow of excess peak supplies (i.e. excess to local capacity) to off-peak when nearest freezing works capacity is unavailable.

Setting holding costs at $100,000 per unit (or $100 per head) results in 'instant' slaughter for all supplies at any transport costs and no inter-period shifts of livestock. At the other extreme, when holding costs are very close to zero, the model minimises costs by ensuring that stock is not transported beyond the nearest works in the peak and substantial use of the holding activity occurs.

Intermediate levels of holding costs establish a quasi demand curve with an inverse relationship between the amount diverted from the peak and the transport cost savings of doing so.

Finally, the terms 'holding costs' and 'holding' do not refer to real storage costs or the amount of livestock actually held through time. They are model variables used for withholding through the peak or getting livestock to pre-peak slaughter; both are equally eligible means of reducing peak throughputs in the model.

3.4 Summary

The LP model is an approximation of reality to estimate excess transport costs for a representative season. Supplies are based on 1974/75 weights applied to 1976/77 aggregate supplies and transport costs are the most recent available (March 1978). A number of simplifications have been included for expediency. Definitions of the product unit and the number of time periods, for instance, are broad and scope exists for their refinement.

Individual works' capacities have been amalgamated, thereby eliminating inter-work distances within demand centres. This is possibly less serious than the procedure adopted to estimate effective monthly capacities. The proportion of individual works' contribution to total annual slaughter was assumed to be valid for each month; monthly throughputs of each freezing works were difficult to obtain and probably distorted in the cases where work stoppages were prevalent. Consequently, the use of effective capacities may not reflect the true potential capacity of the works, but in the short run they are a suitable measure of the quantities of stock which can be handled.

The supplies used in the study rely heavily on survey data compiled two years before the 1976/77 season. Support for the validity of the supply weightings is difficult because no subsequent surveys duplicate the original regions or objectives. There remains, therefore, the assumption that conditions and relative regional supply weights have not changed dramatically since 1974/75.

CHAPTER 4

RESULTS AND CONCLUSIONS

4.1 The Costs of Excess Transport

The results that follow can be compared with an estimate of the actual transport bill which is based on data from an independent source. Chudleigh et al.(1978) give tables of slaughter statistics by region and weighted average transport costs for the 1974/75 pattern of livestock movement. Further, the report estimates the aggregate transport cost for New Zealand from farm gate to freezing works for lamb and sheep. With this information it is possible to extract a South Island estimate for 1974/75 of $7,544,919.

To be consistent with other transport costs in the model an adjustment to the above aggregate cost is necessary. The cumulative increase in road transport rates (supplied by the Road Transport Association) from the 1974/75 season to early 1978 was 37.8 per cent. If this increase is applied to the 1974/75 estimate, a revised total collection cost for South Island lamb equivalents of $10,403,788 is obtained.

The first model scenario, with a low cost of diverting peak supplies from same period slaughter, generates a transport cost total of $7,951,282 - a reduction of $2,452,506 in comparison with the 'actual estimate'. In this case, the cost per unit of holding was set at a negligible rate to simulate a situation where farmers are indifferent to supplying peak livestock in the peak or off-peak. The results of this simulation would suggest that the total excess transport cost between the farm gate and the freezing works is $2,452,506. Table 5 describes the pattern of transport flows and the extent of holding for each separate region.

A measure of the significance of seasonality to excess transport is approximated where holding costs are set at a prohibitive level ($100 per LE) for all supply regions. Since transport costs from any farm to any freezing works do not approach this level it is clear that peak supplies will be slaughtered at any works to avoid these high withholding costs. This case is representative of actual conditions because it allows farmers to have lambs processed in a prime condition. In other words, withholding may produce transport savings but they can be outweighed by the cost to the farmer of differences in sheep weight and/or quality. Under the existing payment system, the latter dominates most suppliers decisions on the timing of slaughter.

Total transport costs in the second case are $8,461,020: an increase of $509,738 over the total cost associated with the initial scenario. This difference can be considered an estimate of that part of excess transport costs which are due to seasonality. Table 6 shows the pattern of movements from regions to destinations when the cost of holding has been increased to such an extent that holding activities have been excluded from the solution.

Holding costs serve as a proxy for realistic incentives for withholding livestock during the peak. For instance, at negligible holding costs sufficient live-stock is withheld to avoid any flows of LE beyond the nearest works. As holding costs rise, less is held but excess transport is still being displaced by the holding activity. Figure 3 summarises the impact of varying cost levels on the holding activity. Basically, this is a quasi demand curve for 'spreading the kill'. For example, if 2,605,000 LE could be excluded from the peak slaughter period in appropriate regions, then all freezing works together would save $0.50 per head in excess transport costs. This relationship suggests viable levels of subsidy that could be offered to producers to withhold different numbers of stock.

TABLE 5

Peak Transportation Flows and Holding
(Holding Costs at Minimal Level)

ORIGIN \ DESTINATION	Stoke	Picton	Christ-church	Smith-field	Pukeuri	Burnside	Balclutha	Inver-cargill	Total	Holding
	(000's of lamb equivalents)									
1 Marlborough		128.5							128.0	
2 Awatere		68							68	
3 Kaikoura		20							20	69
4 Golden Bay,Waimea	118								118	
5 Buller,Inangahua	35								35	25
6 Westland			39						39	
7 Amuri			157						157	
8 Cheviot			79						79	
9 Waipara			178						178	
10 Ashley			128						128	
11 Rangiora			29						29	
12 Eyre,Oxford			147						147	
13 Malvern,Tawera			246						246	
14 Paparua,Waimairi, Heathcote & Mt Herbert			50						50	
15 Akaroa,Waimea			79						79	
16 Ellesmere			147						147	
17 Ashburton									0	471
18 Strathallan				343					343	
19 MacKenzie				500					500	
20 Waimate				497.7					497.7	42.3
21 Waitaki					461				461	
22 Waihemo,Waikouaiti						225			225	
23 Dunedin Area						196			196	
24 Bruce							314		314	
25 Clutha							450.8		450.8	394.2
26 Taupere										364
27 Maniototo						109.9			109.9	351.1
28 Vincent										256
29 Lake								108	108	
30 North Southland								727	727	
31 Invercargill								540	540	
32 Wallace,Fiordland								885	885	
	153	216	1279	1340.7	461	530.9	764.8	2260	7005.4	1972.6

TABLE 6

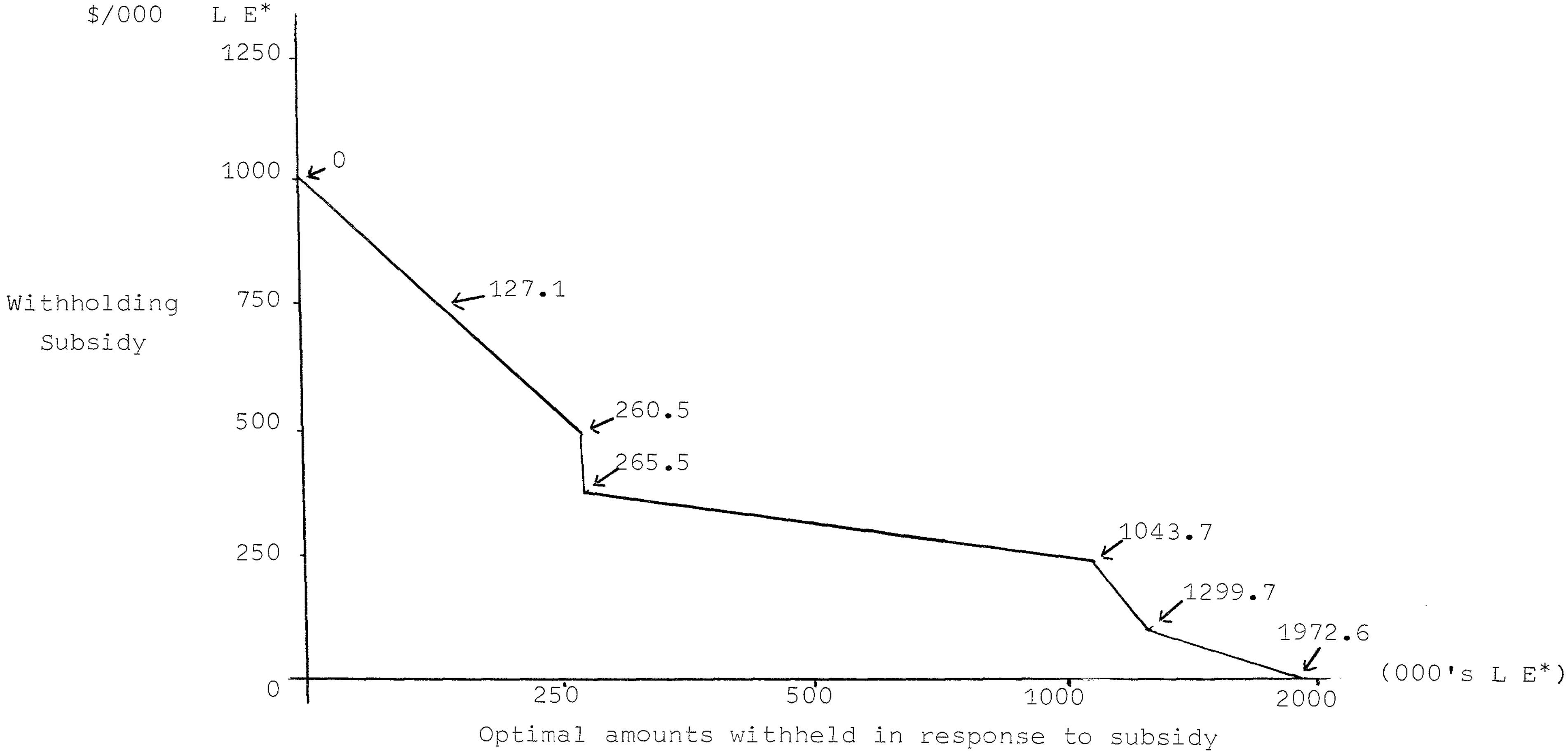
Peak Transportation Flows and Holding
(Holding costs at a prohibitive level)

('000's of lamb equivalents)

DESTINATION / ORIGIN	Stoke	Picton	Christ-church	Smith-field	Pukeuri	Burnside	Balclutha	Inver-cargill	Total	Holding
1 Marlborough		128							128	
2 Awatere		68							68	
3 Kaikoura			89						89	
4 Golden Bay, Waimea	118								118	
5 Buller, Inangahua	35	20	5						60	
6 Westland			39						39	
7 Amuri			157						157	
8 Cheviot			79						79	
9 Waipara			178						178	
10 Ashley			128						128	
11 Rangiora			29						29	
12 Eyre, Oxford			147						147	
13 Malvern, Tawera			246						246	
14 Paparua, Waimairi, Heathcote & Mt Herbert			50						50	
15 Akaroa, Waimea			79						79	
16 Ellesmere			147						147	
17 Ashburton			471						471	
18 Strathallan			169.4	173.6					343	
19 MacKenzie				500					500	
20 Waimate				540					540	
21 Waitaki					461				461	
22 Waihemo, Waikouaiti						225			225	
23 Dunedin Area						196			196	
24 Bruce							314		314	
25 Clutha							359.7	485.3	845	
26 Taupere								364	364	
27 Maniototo				127.1	132.9	109.9	91.1		461	
28 Vincent								256	256	
29 Lake								108	108	
30 North Southland								727	727	
31 Invercargill								540	540	
32 Wallace, Fiordland								885	885	
	153	216	2013.4	1340.7	593.9	530.9	764.8	3365.3	8978	0

FIGURE 3

A Quasi-Demand Curve for Peak Supplies
to be Slaughtered in Off-Peak as Holding Costs Vary



* L E = Lamb Equivalents

Farmers, on the other hand, have a supply curve for withholding livestock which depends on their individual circumstances. The intersection of both the industry demand curve and farmers' supply curve could establish an equilibrium level of holding activity - the cost of which is matched by cost savings of reduced excess transport. These points of demand and supply equilibrium may occur at relatively low prices and still be effective: several freezing works have offered early season processing incentives at $0.50 per lamb which have significantly lowered peak throughputs.

4.2 Implications for Destinations and Supply Regions

In addition to aggregate transport costs, results were produced which have practical implications for changes in regional processing capacities and supplies. This set of results is useful in discussion of the following types of questions:

- What are the transport cost-savings of increasing capacity in particular regions?
- What are the transport cost impacts of an expansion of supply in particular regions?
- In which regions will the withholding of livestock yield the greatest transport cost savings?

4.2.1 Implications for destinations. Table 7 shows the relative impacts of marginal capacity changes for the eight freezing works centres on the total cost of transporting livestock. The resulting marginal impacts or savings are those changes in total cost which could occur if capacity at any of the works centres could be increased by a single unit of throughput during the peak. These results were derived from the scenario in which holding costs are prohibitively high to simulate what is thought to be the current situation.

The results show that increasing slaughter capacity in the Christchurch centre of freezing works does not create transport savings because effective capacity exceeds supplies available within an efficient assembly radius. At the other extreme, transport cost savings are greatest at the Burnside centre where ostensibly local supplies during the peak are unable to be processed and must bypass Burnside. Clearly, expansion of effective capacity at Burnside eliminates works bypassing for one unit of lamb equivalents thereby generating a substantial cost saving. Reduction of Burnside's capacity has a high marginal cost for precisely the same reason.

Finally, the results from Table 7 are crucially dependent on the assumptions of effective capacities for each processing centre. Each capacity is an average over seven seasons but these do vary considerably between years. To test the stability of the above results an alternative model was considered with capacities set at the 1976/77 levels of historical throughputs. Variation in capacities between years for individual works can be seen in Table 4. The corresponding set of results to Table 7 (not tabled) for the revised model was not significantly different. For example: the three highest ranked destinations in Table 7, namely, Burnside, Pukeuri and Balclutha, were in similar positions in the revised results and for both models Christchurch was lowest ranked. This comparison indicated that the transport cost savings in Table 7 are relatively robust and apparently derive, not so much from the absolute capacity constraints assumed, but from locations and volumes of livestock in the peak relative to effective capacity.

TABLE 7

Transport Cost Savings per unit Increase in Effective Capacity at each Works Region

Rank	Destination	Savings ($ per 1,000 lamb equivalents)
1	Burnside	817
2	Pukeuri	792
3	Balclutha	552
4	Smithfield and Pareora	531
5	Stoke	367
6	Invercargill and Bluff	256
7	Picton	155
8	Christchurch	-

4.2.2 Implications for Supply Regions. Changes in supplies from a particular region can be analysed in a manner similar to demand centres. There are transport costs associated with increasing seasonal supplies in specific regions given existing freezing works capacities. These costs stem from two distinct sources: firstly, an added unit of supply must be transported from the region to a works, and secondly, the added unit of supply may be sent to a works with a capacity constraint thereby displacing an alternative unit of supply. Indirect costs in the latter case may be substantial when the original displacement initiates a series of reallocation adjustments.

Table 8 lists supply regions together with their respective marginal supply costs. Costs range from zero in Christchurch (which has coincident supply and demand centres) to Maniototo with a marginal supply cost of $1,552 per 1,000 LE. To recapitulate: an increase of one unit of supply from Maniototo during the peak, all other things being equal, will incur a transport cost of $1,552 or $1.55 per lamb equivalent. The reason for such a high cost relates to the two factors mentioned above. First Maniototo's supplies have a long distance to travel to a freezing works in the peak, and second, indirect costs from other suppliers' readjustments are also significant. Determination of the relative importance of these two factors is discussed below.

The second column in Table 8 titled marginal savings from withholding, differs from the marginal supply cost in one respect: attention is exclusively directed at the indirect costs associated with capacity constraints at freezing works. Whereas adding a unit of supply to total supply incurs a transport cost, diverting one supply unit from the peak to the off-peak retains its transport cost but affects indirect costs. Alternatively, marginal savings from withholding lists the relative savings attributable to withholding livestock in individual regions.

TABLE 8

Transport Cost of Increasing Supply and Withholding by One Unit (1000 LE)

(Holding Costs at a Prohibitive Level)

Region	Marginal Supply Cost ($)	Marginal Savings from Withholding ($)
1 Marlborough	457	155
2 Awatere	589	155
3 Kaikoura	904	89
4 Golden Bay, Waimea	801	367
5 Buller, Inangahua	1419	367
6 Westland	1375	0
7 Amuri	738	0
8 Cheviot	658	0
9 Waipara	500	0
10 Ashley	290	0
11 Rangiora	290	0
12 Eyre, Oxford	461	0
13 Malvern, Tawera	461	0
14 4-Christchurch Counties	0	0
15 Akaroa	195	0
16 Ellesmere	347	0
17 Ashburton	560	32
18 Strathallan	773	531
19 MacKenzie	1165	531
20 Waimate	868	531
21 Waitaki	1248	742
22 Waihemo, Waikouaiti	1268	817
23 Dunedin Area	1182	817
24 Bruce	814	552
25 Clutha	889	552
26 Tuapeka	1277	601
27 Maniototo	1552	817
28 Vincent	1386	489
29 Lake	1179	256
30 North Southland	742	256
31 Invercargill	256	256
32 Wallace, Fiordland	852	256

A number of regions have marginal savings from withholding values equal to zero. All of the regions in question send supplies to Christchurch which (as seen above) has excess capacity during the peak. An increase in withholding supplies during the peak will not alleviate a capacity constraint because one does not exist. On the other hand, the highest value for marginal savings from withholding occurs in Waihemo, Waikouaiti, Dunedin area and Maniototo. Increased supplies from these three regions would give rise to indirect costs of $817 per 1,000 LE or $0.82 per LE. This information effectively indicates that peak capacity is sufficiently limited in the works nearest these regions to warrant a supply subsidy of $0.82 per head for withholding, based on transport savings alone.

Comparison of marginal supply costs and marginal savings from withholding reveals interesting characteristics about regions. For instance, Maniototo has a high cost in both categories with implications for policy concerning long run supplies and the desirability of withholding livestock. Buller, Inangahua is a region with the second highest marginal supply cost ($1,419) but a low marginal saving from withholding ($367). Here, policy must make a distinction: increasing absolute supply is costly owing to the distance from Buller, Inangahua to a freezing works while withholding livestock during the peak is much less beneficial in terms of lowering aggregate transport costs.

4.3 Conclusions

The major objective of this report was to estimate the magnitude of excess transport costs. Estimated excess transport costs were $2,452,506, representing 24 per cent of estimated actual transport costs from farm to freezing works. Furthermore, the relative importance of seasonality as a cause of excess transport was estimated to be in the range of $509,738 or 4.9 per cent of total transport costs.

The estimate of seasonality costs in total transport costs is likely to be an underestimate of the true value. For convenience, the model was composed of a single peak comprised of three months; yet most supply regions and hence demand centres, experience congestion for irregular periods lasting less than three months. If peak pressures were only 4-6 weeks in duration, say, and at different times throughout the South Island, it is probable that works bypassing and excess transport costs due to seasonality would exceed the magnitude reported above.

Nevertheless, seasonality was less significant in relation to transport costs than expected: it accounted for only a quarter of a large excess transport charge. Other factors - notably those associated with spatially inefficient flows - appear to be very substantial. Rationalisation of livestock collection, it appears, is less a question of intractable supply peaks than of conscious decisions of suppliers and freezing works to support long distance supply links.

Given the existing locations and capacities of freezing works there is a wide variation in marginal supply costs among supply regions. This implies that supply cost comparisons among regions could be a basis for encouraging expansion of supplies given existing effective capacities at freezing works.

Similarly, the cost savings from effective capacity increases could provide a basis for recommendations to freezing works as long as regional supplies are expected to remain stable. Even with minor variations of capacity, it was seen, certain works may warrant expansion of capacity as far as transport costs are concerned.

It should be noted that the effective capacities used in this study are below the potential or rated capacities of these works. Since slowdowns and strikes affect the effective capacity of the works these costs can be interpreted as a part of the national cost of such activities.

The LP model has enumerated the most efficient farm to works flow patterns for two periods and at several levels of holding costs. Most freezing work centres have specific and exclusive areas from which livestock should be collected for processing. Proposals aimed at reducing excess transport costs, therefore, might include delineation of assigned zones for collection or other zoning regulations. However, the impact of such measures on other factors such as filling export orders, etc. would need careful consideration.

An efficient transport system, moreover, would require that excess transport costs, paid by either freezing works or meat export companies, should not undermine Schedule Prices via the deduction of indirect operating costs. Over the medium to long term, freezing works with excess capacity would need to subsidise long distance supply flows from, presumably, processing economies of scale, export contract bonuses, etc.

Another important conclusion from the model results is that withholding subsidies in some regions are economically feasible. The results show however that the level of these subsidies should vary between regions to allow the greatest possible saving in transport cost. This study does not provide an estimate of how much stock producers would be prepared to hold at these subsidy levels, but merely the amount which the industry could be prepared to pay.

Four important subjects of further investigation have been neglected but remain complementary in any analysis of rational collection practices. First, transport routes and costs from freezing works to ports deserve to be examined as part of a total transport minimisation model. Second, freezing works operate with varying economies of size. It is possible that efficient works may warrant collection of supply from distant points involving works bypassing. Simultaneously, reducing peak throughputs could diminish some labour related costs and problems. Third, one overlooked benefit of minimising collection costs is the advantage of saving imported oil and scarce foreign exchange. Fourth, heavy cartage vehicles impose high road wear damage. Reducing transport distances could create savings in road maintenance costs.

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