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**REGIONAL SUPPLY RESPONSES AND MULTIPLIERS
FOR THE NEW ZEALAND SHEEP SECTOR**

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ABSTRACT

The sheep sector in New Zealand has been contracting for some time. This decline has been more pronounced in the North Island than in the South Island, where opportunities for substitution into beef and dairy are limited. Pastoral sector supply responses and multiplier impacts based on inter-industry transactions have so far been studied only at the national level.

To facilitate better understanding of the prospects for pastoral activities and the impacts on the regional economy, a disaggregated supply response model and input-output tables were developed. The use of economic and climatic factors specific to the two regions in the sub-models also enabled better specification and forecast accuracy.

* The views expressed in this paper are those of the authors and do not necessarily reflect the official view of the New Zealand Ministry of Agriculture and Fisheries. The typing assistance of Frances Roche and comments from colleagues are very much appreciated.

REGIONAL SUPPLY RESPONSES AND MULTIPLIERS FOR NEW ZEALAND SHEEP SECTOR

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I INTRODUCTION

In New Zealand, pastoral sector supply responses (SriRamaratanam and Reynolds, 1990) and the multiplier impacts (Narayan and SriRamaratanam, 1992) have been investigated at the national level. This has been preceded by studies of the New Zealand pastoral sector by Laing and Zwart (1983), Shaw (1986), and subsequent updates by Grundy, Lattimore and Zwart (1988), which also studied supply responses at the aggregate level. While these studies have provided valuable insights into the factors determining the nature of supply response and its dynamics, regional differences in pastoral activities have not been addressed.

The development of a disaggregated pastoral model, by the North and South Island regions of New Zealand, which are distinct geographical entities separated by the Cook Strait, and the derivation of the respective output, income and employment multipliers, was considered necessary to enable better understanding of changes in the enterprise mix of sheep, beef and dairy activities and their associated impacts on these two regional economies. In this paper, only the sheep sector supply responses have been reported for the two regions of New Zealand and the associated multiplier impacts discussed.

II BACKGROUND

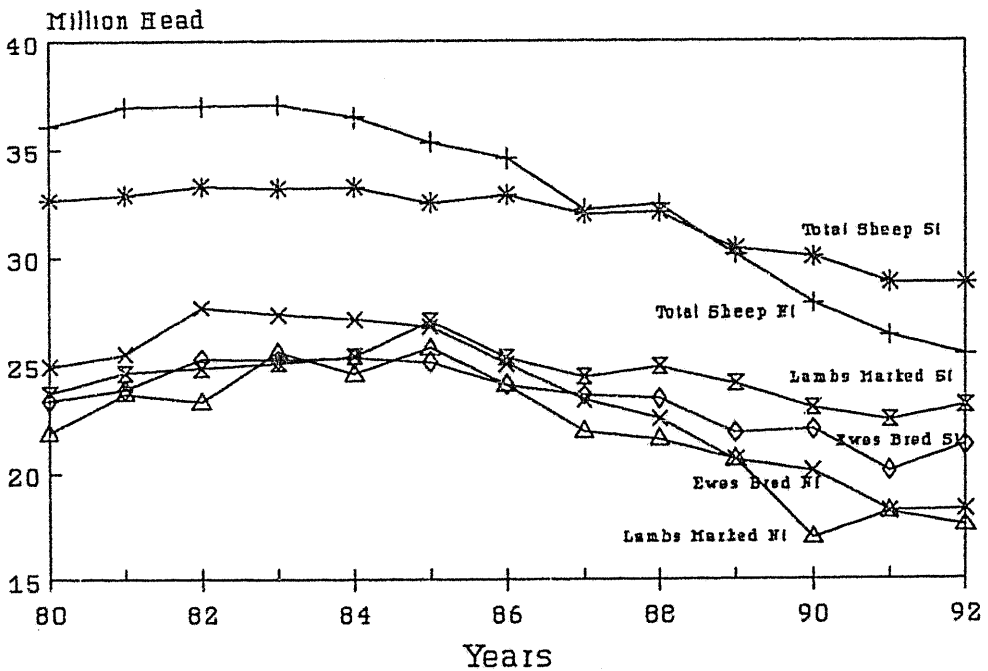
The sheep industry of New Zealand has been one of the mainstays of all pastoral activities for many years. Sheep activity was at its peak level in the early 1980s, when sheep numbers in New Zealand exceeded 70 million and there were more sheep in the North Island than in the South Island (figure 1). Since 1982, sheep numbers in New Zealand have declined by varying degrees, initially by about 2-3% annually, and in more recent years by up to 5-6% in some years (eg. 1989). While the sheep sector has been contracting in New Zealand for some time now, this decline has been more pronounced in the North Island than in the South Island. This can be observed in figure 1, where the number of breeding ewes in the South Island have been higher than in the North Island since 1987 and total sheep numbers have been greater since 1989. Lambs marked in the South Island have been greater than in the North Island for most of the 1980s, mainly due to higher lambing percentages.

Over the ten year period since 1982, total sheep numbers declined by about 23% overall but by over 30% in the North Island and by less than 15% in the South Island (figure 1). This overall decline in sheep numbers was the result of reduction in the profitability of sheep farming, mainly due to lower lamb and mutton prices as well as substantial reduction in wool prices in

more recent years. The relatively greater decline in sheep numbers in the North Island than in the South Island however, is attributable to the greater profitability of beef and dairy farming relative to sheep farming over the recent past, especially in the North Island (NZMWBES, 1992). The existence of more opportunities for beef and dairy activity in the North Island in terms of land use and animal health reasons which make sheep farming more difficult in the North Island have also contributed to these developments. There were major climatic events of catastrophic proportions such as Cyclone Bola in the East Coast of the North Island in 1988 followed by a major drought in 1989, which damaged pasture severely and resulted in reduced feed ability forcing farmers to destock in this North Island region.

Figure 1

Total Sheep, Ewes Bred & Lambs Marked
Disaggregated By North & South Islands



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III OBJECTIVES OF THE PAPER

The work necessary for this paper was carried out following the recognition that a disaggregated pastoral model was required to facilitate better understanding of the prospects for pastoral activities and the economy on a regional basis. The use of economic and climatic factors specific to the two regions in the sub-models was intended to enhance model specification and estimation. Thus the specific objectives of this paper are as follows:

- (a) to report the results of the disaggregated supply response model for the sheep sector;
- (b) to understand better the impacts of both economic and climatic factors on key sheep sector behavioral equations such as the number of breeding ewes, lambs marked, lamb and adult sheep slaughter and death rates as well as the unit slaughter weight and fleece weight equations in the two regions;
- (c) to enable regional forecasts of prospects for the sheep sector, in the medium term in terms of lamb, mutton and wool production, as well as the inventory of total sheep, breeding ewes, etc; and
- (d) to link the regional production forecasts with regional output, income and employment multipliers for the sheep sector to estimate the regional on and off-farm economy-wide impacts.

IV DATA SOURCES AND AVAILABILITY

The main data categories required for the development of the disaggregated regional model are similar to the national model, but the availability of the necessary data however, was not always equally forthcoming. The sheep sector inventory data was extracted from the New Zealand Agricultural Statistics which reports the results of the 'annual' Agricultural Census Surveys carried out by the Department of Statistics and was available from 1960-1992. This included total sheep, breeding ewes and lambs marked for North and South Islands.

The source of slaughter statistics of lambs and adult sheep for the two regions was the Ministry of Agriculture and Fisheries, which receives and compiles data on inspected kill at both export meat works and local abattoirs and this data was available from 1975 to 1992. The disaggregated weight of production data for the two regions however, was available only from 1982-1992 and thus the unit slaughter weights of lambs and adult sheep data were also available for only about ten years. The paucity of this data was a major limiting factor in the estimation of the respective equations. The lamb and adult sheep death rates were obtained from the New Zealand Meat and Wool Board's Economic Service (NZMWBES) survey results for the North and South Island farm classes. These death rates were then applied on the lambs marked and the total adult sheep numbers to derive the lamb and adult sheep deaths respectively, for the two regions.

Annual Reviews of the NZMWBES and the Annual Reports of the New Zealand Meat Producers Board (NZMPB) were the source of the data for lamb, mutton, prime and manufacturing beef prices in the North and South Island regions and were available only from 1976. The prices paid indices for North and South Island sheep and beef farms were also computed from the main NZMWBES farm classes' farm cost inflation estimates for the period 1976-1992.

The shorn and slipe wool production and price data for the two regions were obtained from the Statistical Handbooks of the New Zealand Wool Board, from which fleece weight and slipe wool per head data were derived for the period 1975-1992. The price data for the North and South Island wool is presented in figure 2 and shows a clear separation over the last 6-8 years when more fine wool has been produced in the South Island fetching higher prices. The wool price difference between North and South Island over the last 3-5 years has been as high as 80¢.

Lamb prices have been between 10¢-15¢ higher in the South Island than in the North Island over the last few years, while mutton prices have been about 10¢ higher in the North Island during the last three years. Prime beef prices have also been higher in the North Island by between 20¢ and 25¢, while manufacturing beef prices have been about 10¢ higher in the North Island during the last 3-5 years. Prices paid index, with a base period of 1981, was also higher in the North Island by about 5-6 units on sheep farms and by about 3-4 units on beef farms compared to the South Island.

The weather indices for sheep farms in the North and South Islands measured as soil moisture deficit days were obtained from the New Zealand Meteorological Service (NIWAR) for the 1976-92 period. In comparison to the national data for sheep farms, the disaggregated data for the North and South Island sheep farms clearly demonstrate a sharp distinction and significantly higher number of soil moisture stress days in the South Island than in the North Island sheep farms (figure 3). The differences for sheep farms are so high that the modal value for the North Island is about 30 days per year, while for the South Island is about 50 days of soil moisture stress days.

Figure 2

Greasy Wool Prices by Regions Averages for NI/SI Auction Centres

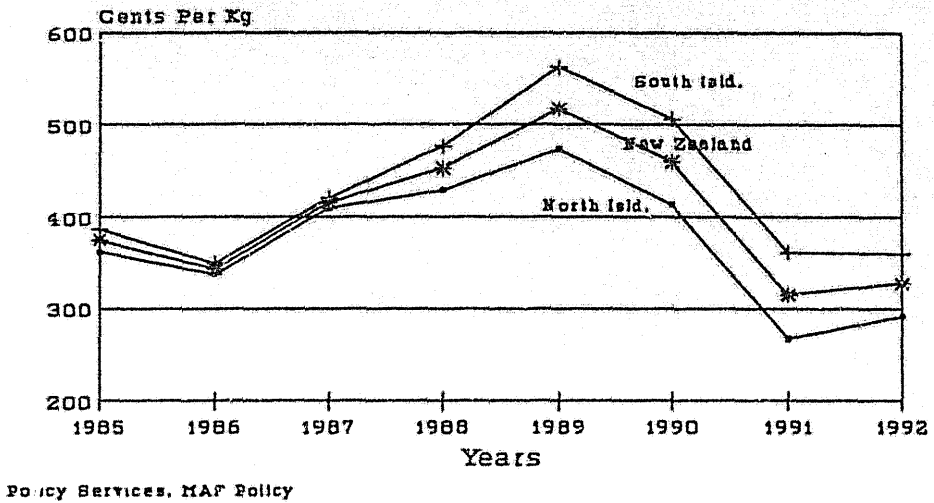
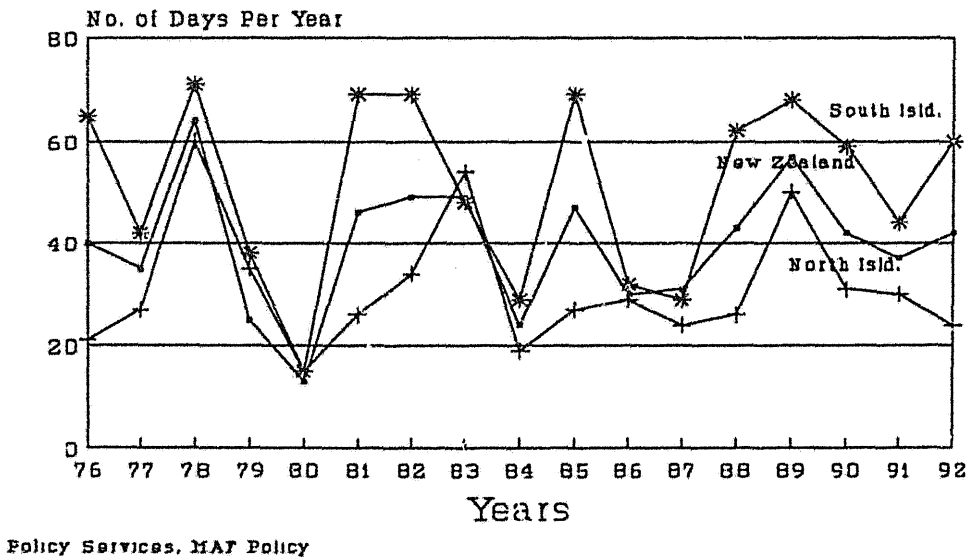


Figure 3

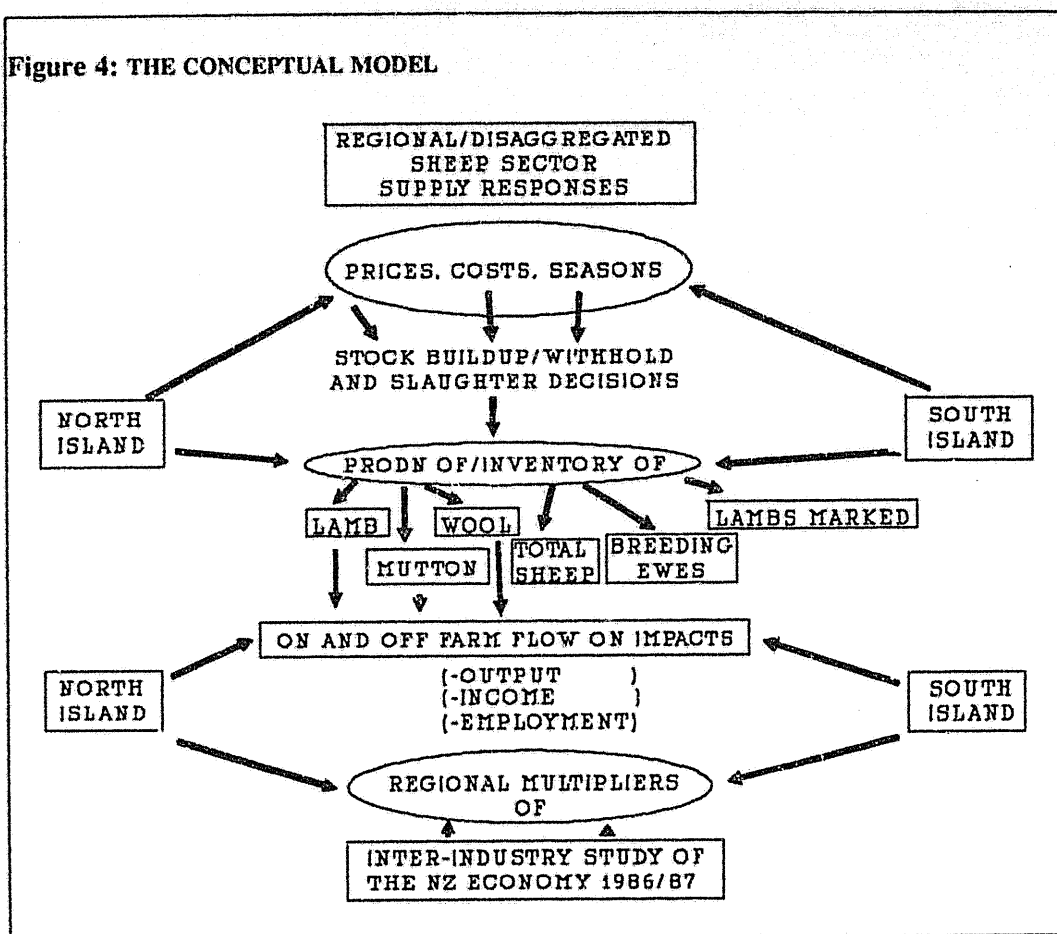
Sheep Sector Soil Moisture Deficit Data Disaggregated By North & South Islands



V THE CONCEPTUAL MODEL

A DISAGGREGATED SHEEP SECTOR SUPPLY RESPONSE MODEL

The focus of this disaggregated supply response model for the sheep sector is to capture the changes in inventories and the level of production of the major outputs; lamb, mutton and wool, from the sheep sector on a regional basis. These changes are modelled as responses to the incentive environment, both prices and costs, arising from domestic policy measures as well as international market developments along with weather and other exogenous influences, which are often different for the North and South Island of New Zealand (figure 4).



The North and South Island sheep flock, as counted at census time, consists of the adult sheep flock and the ewe and wether hoggets being promoted. The lamb crop of this season contributes towards a buildup of the adult flock next season through promotions as hoggets. Alternatively, the flock is run down through deaths and slaughter of lambs and/or adult sheep, respectively. Breeding ewes are an important component of the adult flock and the breeding decisions of sheep farmers in the two regions this season determine the lambs marked in the

subsequent season. Here the weather and price factors determine the number of ewes bred and also the lambs marked. The sheep component of the model for the two regions is closed by a closure factor in the adult sheep inventory relationship.

Prices of the joint products from the sheep sector (lamb, mutton and wool), along with the price of beef, determine the breeding decisions in the two regions which lead to stock buildup next period. It also determines the slaughter decisions of both lambs and adult sheep in the two regions, which result in stock decline. Weather determines seasonal pasture availability and becomes important not only in the breeding and slaughter decisions of farmers but also determines the loss of lambs and adult sheep on farms through deaths. In this analysis, weather conditions for sheep farming in the North and South Island of New Zealand is defined as the number of soil moisture stress days. It is measured by the meteorological service and recorded for the different sheep growing regions and weighted according to the sheep numbers.

Output of the joint products from the sheep sector are measured through changes in the slaughter numbers in the case of lamb and mutton (adult sheep) and the corresponding average slaughter weights, while wool production is determined from sheep wintered and average fleece weights. These weights are again determined by weather, both current and previous season in the case of wool, along with prices of the respective products and a trend variable representing the changes in the technology (management) of on-farm production and/or market preferences for heavier or lighter animals.

The price variables are generally defined in real terms, where they are measured as ratios of nominal prices to the prices paid indexes of the respective farming activity in the different years. The inventory and slaughter numbers are measured on a June year ending basis and the study period for the sheep sector is 1976-1992. But the estimated sheep sector equations cover only 15 years of data from 1977-91, due to the nature of changes in inventory reconciliation and the lagged effects of weather and sometimes prices on the endogenous variables represented by the behavioral equations.

B INTER-INDUSTRY TRANSACTIONS AND DERIVATION OF REGIONAL MULTIPLIERS

An inter-industry study is an economic statement of the industrial structure of a nation's (or a region's) economy for a given year. It records how much each industry purchases from, and sells to, other industries and also measures the indirect relationships between industries. It can be used to show the probable effect throughout the economy (or region) of rises or falls in demand for one industry's products.

An inter-industry study requires a systematic collection, evaluation, and arrangement of a vast body of statistical information on production and consumption covering, to the extent possible, every area of the economy at a specified level of industry aggregation. The New Zealand Department of Statistics released the full inter-industry tables for the 1986/87 year at the

national level in 1991. Butcher (1993) developed the inter-industry tables at the regional level for the 1981/82 year, and then by using the 1986/87 national table, updated the regional tables to the 1986/87 year. In the process, Butcher also derived the inter-industry tables for the North and South Islands for the 1986/87 year, at the 80 industry level.

The inter-industry transaction tables for the two regions (North Island and South Island) were then incorporated into the 'IO7 package', an application software (Guy West, 1992). The employment data was adjusted to reflect the seasonal nature of employment in some industries. The house-hold income and operating surplus were also adjusted to take into account self-employed income. The IO7 package was then used to calculate the *technical coefficients* and the *output, income, and employment multipliers*. The calculated multipliers accounted for the backward industry linkages only. Narayan and SriRamaratnam (1992) have demonstrated that the forward linkages for New Zealand's sheep sector is very strong. Thus, the multipliers calculated using the IO7 software were adjusted to include the forward linkages. The process of incorporating the forward linkages is detailed in Narayan and SriRamaratnam (1992).

VI RESULTS OF ANALYSIS

Results reported in this section cover both the estimation of the disaggregated (North and South Island) supply response model for the sheep sector of New Zealand and the regional multipliers for the same two regions derived from the 1986/87 inter-industry study of the New Zealand economy.

A SUPPLY RESPONSE MODEL

The sheep sector behavioral equations for the two regions are reported in the appendix and the model validation statistics as well as forecast regional sheep inventory and production levels for the medium term (1993-1997) are reported in this section.

Disaggregated Model Equations

Equations representing inventory adjustments on a June year basis as well as turn off/slaughter of both lambs and adult sheep are reported in the appendix. Inventory adjustments are represented by breeding ewes and lambs marked equations for the North and South Island regions separately and are estimated over a 15 year period (1977-1991). In addition, lambs and adult sheep death equations are also reported and were estimated over a sample period of 1977-1990. Both lamb and adult sheep slaughter weights for the two regions were available for only about ten years from 1982-1992. Finalised 1992 data was not available for many categories of variables and thus was not included in the estimation.

The sheep farmers' decisions on breeding their ewes and the resulting lambs which are marked in the North and South Island are determined by the size of the available sheep flock in the beginning of the season (KSNL and KSSL), seasonal weather factors (WSN and WSS) as well as the adaptive real prices (these are weighted prices of current (0.6) and previous (0.4) periods) of lambs (APLPPN and APLPPS) and prime beef (APPBPPN and APPBPPS) received in the North and South Island regions, respectively. Even though the breeding ewe equations for the North and South Island exhibit identical specifications, the magnitude of all the parameter estimates appear to be higher in the South Island equation. The standard errors of estimates were however, somewhat higher in the South Island and thus the reported *t*-statistics were slightly lower, but still significant at the 5% level in the case of most parameter estimates. The overall fit of the breeding equations were satisfactory with R^2 values of around 0.85 to 0.95 and *F* statistics also significant at the 1% level (Appendix table 1).

Similarly, the lambs marked equation also exhibited a high degree of explanatory power with R^2 values over 0.85 and significant *F* and *t* statistics in most cases. Lambs marked depend on both ewes bred (KENL and KESL) and the weather in the previous season along with the adaptive real prices of lamb and prime beef in the North and lamb and wool prices in the South Island regions, respectively. Lagged weather impacts, which are obviously negative on lambs marked, were considerably larger in the North than in the South Island.

The size of the parameter estimate on ewes bred the previous season was however, higher in the South Island (1.082) than in the North Island (0.925) lambs marked equation. These values are consistent with the notion of lambing ratios or percentages which have been considerably higher in the South Island for many seasons (NZMWBES, 1992). Adaptive lamb prices were found to be positive and significant in terms of magnitude as well as *t* values in the lambs marked equation for North Island, while being negative and not significant in the South Island. Adaptive prime beef price impacts were negative for the North Island and adaptive wool price impacts were positive for the South Island, in the respective lambs marked equations.

Lamb slaughter equations (SLLN and SLLS) in turn are a function of lambs marked (LMN and LMS), adaptive real price of lamb and prime beef (North Island) or wool (South Island), as well as weather which affects death rates at lambing, especially in the case of South Island. Both lamb slaughter equations also had a high degree of explanatory power with R^2 values of around 0.90 and significant *F* and *t* statistics in most cases. The size of the parameter estimate on lambs marked in the North Island lamb slaughter equation (0.972) was somewhat higher than in the corresponding South Island equation (0.820), a likely indication of greater number of hoggets retained for general stock maintenance as well as for wool production in the South Island than in the North Island. Moreover, adaptive wool prices impacted positively in the South Island lambs marked equation, discussed before, but exhibited a negative impact in the South Island lamb slaughter equation, which further reinforces the growing emphasis of retaining stock for wool production in the South Island when wool prices rise.

Adaptive lamb prices had a negative impact in the North Island lamb slaughter equation, which is consistent with the short term response of withholding stock for further build up, while adaptive prime beef prices had a positive impact on lamb slaughter in the North Island, indicating substitution away from sheep and possibly towards beef farming. Adverse weather had an impact of increasing lamb slaughter in the South Island, while not demonstrating similar pattern in the North Island.

Adult sheep slaughter depends on the opening inventory of the adult sheep flock (KASNL and KASSL), current weather (WSN and WSS) as well as adaptive lamb (APLPPN and APLPPS) and prime beef prices (APPBPPN), latter found important only in the case of North Island. These equations did not exhibit a high degree of explanatory power (R^2 value of around 0.50 only) as those discussed before and this result was similar to that in the national supply response model (SriRamaratnam and Reynolds, 1989). A larger adult sheep flock can support a bigger slaughter number, which in turn further increases under drought weather conditions which affect seasonal pasture availability, causing destocking.

The size of the parameter estimates on adult sheep flock in adult sheep slaughter equations suggest similar impacts with respect to the proportion of the adult flock slaughtered (0.150 approximately) in the two regions, but the impact of adverse weather on adult sheep slaughter in the South Island (18.6) was somewhat greater than in the North Island (14.4). Adaptive lamb prices had a negative impact and adaptive prime beef prices a positive impact on adult sheep slaughter in the North Island, as was the case in the lamb slaughter equation. Lamb deaths are mostly determined by the number of lambs marked (LMN and LMS) and the weather in the previous period (WSNL and WSSL), which influences the condition of the ewes and also the lambs which are born. Similarly, adult sheep deaths are also influenced by the size of the adult flock (KASNL and KASSL), current season's weather (WSN and WSS) and adaptive real prices of mutton (North Island) or wool (South Island). Once again, lamb and adult sheep death equations exhibited relatively lower degree of explanatory power as in the national supply response model.

Nevertheless, it appears that a larger proportion of lambs marked and the adult flock perish in the North Island than in the South Island, possibly due to unfavourable animal health conditions, along with experiencing greater impacts from adverse weather on lamb and adult sheep mortality in the North than in the South. Adaptive real mutton and wool prices exhibited a negative impact on North and South Island adult sheep deaths respectively, while adaptive real lamb prices also had a negative impact in the lamb death equations in both regions.

Disaggregated Supply Response Model Validation

The key endogenous variables modelled in the disaggregated supply response model were simulated over the base period (1977-1991) and model validation was carried out by comparing these predicted values with the actual data for the North and South Island regions. The specific statistical measures used for this validation process were (a) the regression co-efficient of actuals on predicted, where a value closer to one (Unity) suggests a good 1:1 mapping of these two values, (b) Theil's inequality co-efficient, a standardised measure of overall error in estimation, where a very low value is preferred, and (c) the proportion of error due to bias, a measure of the degree of consistent over or under estimation, where once again a small fraction indicates a low level of bias (table 1).

<u>Endogenous Variables Modelled</u>	<u>Regn Coefficient of Actual on Predicted</u>		<u>Theil's Inequality Coefficient</u>		<u>Error due to Bias</u>	
	<u>NI</u>	<u>SI</u>	<u>NI</u>	<u>SI</u>	<u>NI</u>	<u>SI</u>
I Breeding Ewes	1.088	1.032	0.07	0.06	0.22	0.02
II Lambs Marked	1.227	1.148	0.06	0.04	0.20	0.10
III Total Sheep	1.182	1.105	0.06	0.05	0.01	0.01
IV Lambs Slaughtered	1.025	1.192	0.10	0.06	0.24	0.15
V Adult Sheep Slaughtered	1.118	0.926	0.09	0.08	0.07	0.05
VI Lamb Deaths	1.006	1.190	0.10	0.06	0.01	0.12
VII Adult Sheep Deaths	0.995	1.200	0.09	0.08	0.01	0.22

In table 1, these measures are reported for breeding ewes, lambs marked, total sheep, lambs and adult sheep slaughter as well as lamb and adult sheep deaths in the North and South Island. They suggest that the dynamic simulation results were satisfactory overall in tracking the actual data over the historical period in that the regression co-efficients of actual on predicted were between 0.926 and 1.227, the Theil's inequality co-efficient was 0.10 or less in all cases and the error due to bias was less than 0.25 in all cases and most often less than 0.10 (table 1).

Considering the individual endogenous variables being modelled, breeding ewes, lambs marked and total sheep were somewhat better tracked by the South Island equations and models than the North Island counterparts, as the respective validation measures were either closer to unity or were lower and thus better represented the actual data. The same was true with respect to both lambs and adult sheep slaughter, while lamb and adult sheep deaths were slightly better captured in the North Island than the South Island equations.

Forecast Sheep Inventory and Output Levels

The estimated regional model and the dynamic simulation framework, along with forecast regional prices of lamb, mutton, wool, prime and manufacturing beef as well as cost and seasonal factors for the medium term (1993-1997) enabled forecasts of inventory (total sheep, ewes bred and lambs marked) and production levels for the key sheep sector outputs (lamb, mutton and wool) in the North and South Island. Regional price forecasts were derived from forecasts made for the national scene by MAF Policy, by employing price linkage relationships between the two respective regional prices and the national prices for lamb, mutton, wool, prime and manufacturing beef. The cost and seasonal differences between the North and South Island regions during the historical period were maintained for the forecast period with the soil moisture stress days being assigned the modal historical values for the two regions. During the forecast period (1993-1997), nominal lamb prices are expected to recover by about 45%, wool and mutton prices by about 50%, while beef prices are to decline by about 15% in relation to 1992 price levels.

Forecast Regional Sheep Inventory Levels

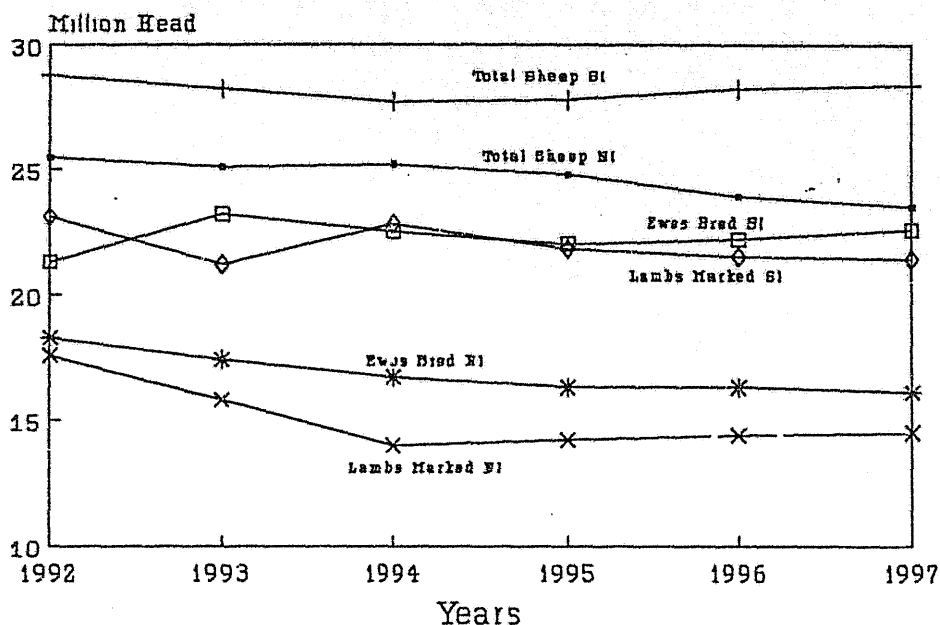
Total sheep numbers in the North island which was around 25.5 million in June 1992 is forecast to decline further during the next five year period (figure 5). This decline will be gradual up to 1995 (24.8 million) and then will be more pronounced with the 1997 number being forecast at 23.5 million, about 2 million head less than in 1992. In the South Island, total sheep numbers are forecast to decline slightly during the next two years (1992-1994), by about 1 million and then recover in 1997 to almost the same level as in 1992 (about 29 million).

Ewes bred in the South Island are forecast to increase in 1993 to over 23 million from about 21.5 million in 1992, which is followed by a decline of about 1 million during 1994-1995, down to 22 million, and then recover to around 22.5 million in 1997. In conjunction with the changes in ewes bred, lambs marked are seen to change with a one period lag. Thus lambs marked in the South Island, recover in 1994 but subsequently decline again to be around 21.5 million in 1997 (figure 5). These changes do reflect the medium term forecast of lamb, wool and beef prices during the corresponding period when lamb and wool prices are expected to recover considerably, while beef prices decline, mainly due to developments in the US beef trade.

In the North Island, ewes bred decline throughout the entire forecast period (1993-1997), but the decline was greater during the 1993-1995 period with some stabilisation in the latter part of the forecast period. Ewes bred in the North Island decline from around 18 million in 1992 to about 16 million in 1997 and associated with this was a decline in lambs marked from about 17.5 million in 1992 down to 14 million in 1994 and then recover to about 14.5 million in 1997 (figure 5).

Figure 5

Regional Sheep Inventory Levels Period of Forecast (1993-1997)



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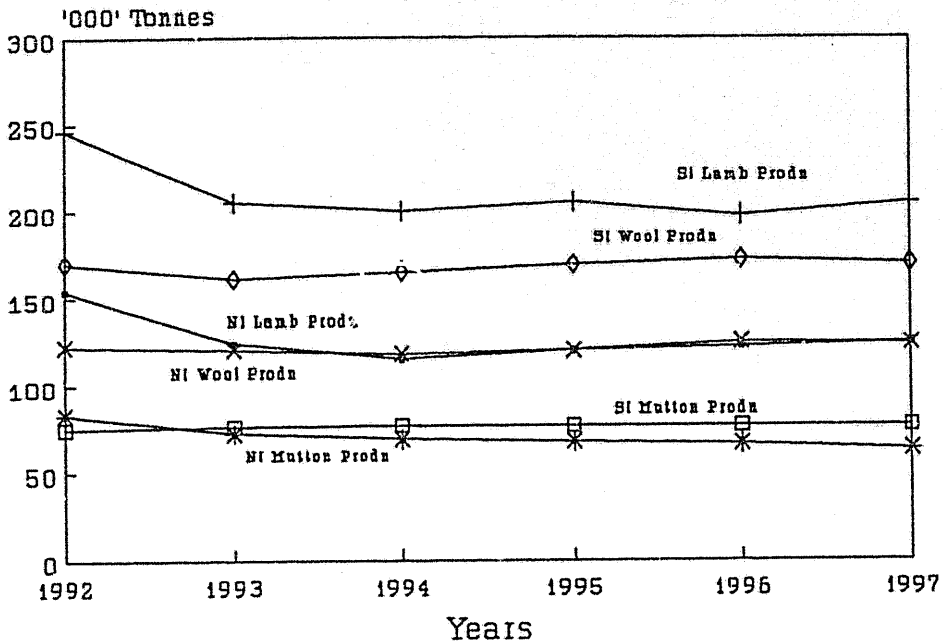
Forecast Regional Sheep Sector Outputs

As a result of the large decline in lambs marked in the South Island in 1993, lamb production also declines from about 250,000 tonnes in 1992 down to about 200,000 tonnes in 1993 and then stabilises around this figure for the rest of the forecast period with some minor fluctuations. Lamb production in the North Island, on the other hand, declines from about 150,000 tonnes in 1992 to about 125,000 tonnes in 1993 and down to 115,000 tonnes in 1994 before recovering gradually to be around 125,000 tonnes again in 1997 (figure 6).

Wool production in the South island is also expected to decline in 1993 to about 160,000 tonnes, down from about 170,000 tonnes in 1992, before recovering gradually to be around 170,000 tonnes once again in 1997. In the North Island, wool production remains at around 120,000 tonnes during the entire forecast period with minor fluctuations. South Island mutton production however, tended to increase slightly over the entire forecast period from about 75 million tonnes in 1992 to almost 77 million in 1997, representing the availability of larger adult sheep flock. Mutton production in the North Island however, declined considerably from about 83 million in 1992 down to about 63 million in 1997, which was consistent with the declining size of the total sheep as well as adult sheep flock.

Figure 6

Regional Sheep Sector Outputs Forecast Period (1993-1997)



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B MULTIPLIER ANALYSIS

Sheep Sector Multipliers

Output, income and employment impacts arising from changes in sheep farming output during the 1986/87 year (known as multipliers) are presented in Table 2. These impacts are presented at the national level and at the regional level for the North and South Islands.

At the national level, each dollar's worth of sheep sector output from sheepmeats, wool etc generated a total impact on the economy of \$6.10. This included a flow-on output effect of \$5.10. Also, one additional dollar of output from sheep farming led to 11 cents of extra household income for those employed within sheep farming, and generated a total household income of 87 cents in the overall economy (ie a flow-on effect of 76 cents). In the case of employment, one million dollars worth of additional output (in 1986/87 prices) from sheep farming created 16 additional jobs in sheep farming itself and another 45 jobs elsewhere in the economy.

	Output		Income		Employment	
	Multiplier	per \$	Multiplier	per \$	Multiplier	per \$m
New Zealand						
Initial Impact		1.00		0.11		16
Total Impact	6.09	6.09	7.77	0.87	3.8	61
Flow-on Impact	5.09	5.09	6.77	0.76	2.8	45
North Island						
Initial Impact		1.00		0.11		16
Total Impact	5.20	5.20	6.64	0.74	3.1	50
Flow-on Impact	4.20	4.20	5.64	0.63	2.1	34
South Island						
Initial Impact		1.00		0.11		16
Total Impact	4.30	4.30	5.28	0.59	2.6	42
Flow-on Impact	3.30	3.30	4.28	0.48	1.6	26

The results in Table 2 also show the output, income and employment impacts for the North and South Island regions. These two regions individually being smaller than the total New Zealand economy, the regional multipliers are found to be somewhat smaller. Although the South Island is geographically larger than the North Island and both had about the same number of sheep in 1986/87, the human population (ie the final consumers) in the North Island is considerably higher. Thus, more value adding activities tend to occur in the North Island, and therefore the flow-on output, income and employment impacts for the North Island were also greater than that for the South Island (Table 2).

For instance, in 1987 every one dollar worth of output from sheep farming in South Island generated a flow-on impact on the South Island economy of \$3.30, while it was \$4.20 in the case of North Island, and \$5.09 in the case of the total New Zealand economy.

The employment impact has a similar trend. As one would expect, the on-farm effect is the same in all the three data set. That is, every one million dollar's worth of sheep farming output creates 16 jobs on a farm. However, the flow-on employment effects are different between the three. In the case of South Island, for every one job on a sheep farm there were 1.6 jobs off the farm, while for North Island there were 2.1 jobs off the farm for every job on the farm, and for New Zealand it was 2.8 jobs off the farm for every job on the farm.

The main reason for the national multipliers to be larger than the regional multipliers is that those farm produce from the South Island that are "exported" to the North Island and get further processed in North Island are not captured by the multipliers of either the North Island or the South Island, but when the national model is used they do get captured as flow-on impacts.

That is, the cause of the difference between the regional and national multipliers is that the outputs are in part being processed in a different region; and the inputs to every industry are, in part, being supplied by the other region. The North Island multiplier takes account of the impact of North Island sheep production on the North Island economy. This, however, misses

out the impact of the South Island sheep sector production which is processed in the North Island. First, the inter-regional trade impacts are excluded (both further processing of South Island exports to North Island, and South Island supply of "imports") and also there are no feedback effects in the regional models since imports are assumed to be exogenous. For instance, a greater North Island dairy production leads to more South Island manufacture of gum boots which leads to more North Island production of chemical resins, which leads to greater production of South Island electricity, and so on. A more sophisticated model would be required to take account of feedback effects.

Sheep Sector Impacts on the Regional Economies

These different flow-on effects become much more obvious in table 3 when the multipliers are converted to actual impacts using the regional output forecasts made in the previous section.

	1987 Actual Impacts	Flow-on Effect %	1992 Actual Impacts	Forecast Impacts	
				Ave 93-97	1997
Output(\$'m,1992 Prices)					
New Zealand	18372	84	12287	15729	16682
North Island	7481	81	4448	5499	6106
South Island	6777	77	4995	6537	6714
Income (\$'m,1992 Prices)					
New Zealand	2624	87	1755	2246	2382
North Island	1070	85	637	786	874
South Island	932	81	686	899	923
Employment(No.of Jobs)					
New Zealand	147316	74	98529	126127	133768
North Island	56574	67	33640	41582	46176
South Island	52926	62	39013	51049	52442

Results in Table 3 show that when the North Island total impacts are added to the South Island impacts, the sum of the two is a lot less than the total New Zealand impact calculated by using the national model. For example, in 1987 the sheep farming sector created a total of 147,316 jobs in the economy, but there were only 56,574 jobs in the North Island and another 52,926 jobs in the South Island. When the North Island jobs are added to the South Island jobs the total is only 109,500 jobs while total jobs is 147,316 when the national model is used.

VIII SUMMARY OF MODEL RESULTS AND POLICY IMPLICATIONS

In this paper, a supply response model for the New Zealand sheep sector, disaggregated by North and South Island regions, and developed over the past six months, has been employed to simulate forecast levels of sheep inventory and production of lamb, mutton and wool in the medium term (1993-1997). These output responses in the underlying price, cost and seasonal factors in the two regions, are then combined with regional multipliers derived from the latest (1986-87) Inter-Industry study of the New Zealand economy to derive the total output, income and employment impacts in the two regional economies.

National supply response models for the entire pastoral sector of New Zealand have been developed and the associated multiplier impacts arising from forecast output levels have been studied in the recent past. These studies have suggested an overall continued decline of the sheep sector in New Zealand. The differential patterns of the past developments and future prospects for the sheep activity in the North and South Island regions, while being recognised to be important, were unable to be studied within a national modelling framework. Limitations on sufficient and suitable data for the two regions separately has hindered model development so far. This disaggregated model for the sheep sector has been estimated with only about 15 years of data, while the national pastoral model employed more than 25 years of data for the sheep industry of New Zealand.

In spite of some shortcomings with data availability, the disaggregated sheep sector model reported in this paper exhibited satisfactory goodness of fit, especially with respect to the key behavioral equations. The simulation results over the historical period also tracked actual data quite well, on the basis of model validation results discussed. Disaggregated model development will be extended to the beef and dairy sectors as well in the near future, to enable a complete understanding of the changes in the pastoral sector as a whole, in the two regions.

Sheep sector results suggest that the decline in sheep numbers will continue both in the North and South Island regions during 1993 and 1994, but at slightly different rates. Sheep numbers then recover back to the 1992 levels in the South Island by 1997, while they decline further to be about 2 million less in 1997 than in 1992 in the North Island. There are corresponding changes in the number of ewes bred and lambs marked being forecast in the North and South Island regions, which result in the above changes in total sheep numbers.

All three sheep sector output levels (ie, lambs, mutton and wool) are forecast to decline in 1993 in both regions, compared to the high levels of production in 1992. In the case of lamb output, production levels stabilise in the South Island at around 200,000 tonnes from 1994 onwards, with minor fluctuations, while in the North Island they decline further in 1994 before recovering somewhat during the 1995-97 period to be around 125,000 tonnes.

Wool production also declines during 1993 in the South Island to around 160,000 tonnes and then recovers back to the 1992 levels of 170,000 tonnes during the remaining forecast period, when sheep numbers also recover. North Island wool production remains at around 120,000 tonnes during the entire forecast period, in spite of declining total sheep numbers. Mutton production is forecast to decline considerably in the North Island and increase somewhat in the South Island.

Regional output, income and employment multipliers derived for the North and South Island sheep sectors, employing the 1986/87 Inter-Industry study, suggest a smaller impact in the two regional economies from a unit of additional sheep sector output compared to the results for the

entire New Zealand sheep sector. This is consistent with the nature of the inter-industry study and the existence of flows between the two regions which are assumed to be exogenous in deriving the regional multipliers. Among the two regions, output (5.20 vs 4.20), income (0.74 vs 0.59) and employment (50 vs 42) total impacts are also higher in the North Island than in the South Island due to the greater size of the economic agents in the North and the associated economic activity. Sheep sector total impacts for the two regions derived from combining the regional multipliers and the regional sheep sector output responses for two historical periods, 1987 (year of the inter-industry study) and 1992 (latest complete year) and the forecast period (1993-1997) provided some interesting results. Sheep sector total output impacts for the North Island, which declined from about \$7.5 billion in 1987 to \$4.5 billion in 1992 are forecast to recover to about \$6.1 billion in 1997, while in the South Island they are forecast to recover almost back to the 1987 levels of \$6.8 billion from about \$5 billion in 1992.

Similarly, employment in the total economy associated with the sheep sector in the North Island recovers to sustain around 46,000 jobs in 1997, after declining from about 56,000 jobs in 1987 down to 34,000 jobs in 1992, while the recovery is forecast to be almost complete in the South Island, back to about 53,000 jobs of 1987 in 1997 after being down to about 39,000 jobs in 1992. These results are however, quite sensitive to the forecast price assumptions and the resulting sheep sector output responses and thus should be treated only as indicative of future patterns of recovery in economic activity in the two regional economies. It is quite evident that the modelling framework developed and the results reported in this paper hold very significant policy implications due to the nature of the regional sheep sector output and employment information possible to be furnished for the medium term.

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APPENDIX TABLE 1: REGIONAL SHEEP SECTOR BEHAVIORAL EQUATIONS FOR NORTH ISLAND (NI) AND SOUTH ISLAND (SI)

(A) INVENTORY ADJUSTMENTS (1977-1991)

							<u>R²</u>	<u>F</u>	<u>DW</u>
(i)	NI BREEDING EWES KEN	= -4657 (-2.08*)	+ 0.840 KSNL (17.20***)	- 15.1 WSN (-1.15)	+ 3396 APLPPN (6.59**)	- 2454 APPBPPN (-2.22*)	0.962	89.2***	2.59
(ii)	SI BREEDING EWES KES	= -9452 (-2.47*)	+ 1.038 KSSL (8.61**)	- 19.5 WSS (-1.73*)	+ 3715 APLPPN (4.07**)	- 2789 APPBPPS (-1.80*)	0.843	19.9***	2.79
(iii)	NI LAMBS MARKED LMN	= 1900 (0.72)	+ 0.925 KENL (10.57**)	- 47.3 WSNL (-2.55*)	+ 1882 APLPPN (2.52*)	- 2212 APPBPPN (-1.38)	0.902	33.4***	2.65
(iv)	SI LAMBS MARKED LMS	= -526 (-0.08)	+ 1.082 KESL (4.85**)	- 16.9 WSSL (-1.51*)	- 282 APLPPS (-1.35)	+ 163 APWPPS (1.19)	0.850	20.9***	2.10

(B) TURN OFF/SLAUGHTER

(i)	NI LAMB SLAUGHTER SLLN	= 11341 (-3.91**)	+ 0.972 LMN (10.19**)	- 1439.8 APLPPN (-1.72)	+ 3925.6 APPBPPN (2.38*)		0.880	35.4***	2.56
(ii)	SI LAMB SLAUGHTER SLLS	= -1448 (-0.36)	+ 0.820 LMS (6.47**)	+ 16.2 WSS (1.78*)	+ 640.3 APLPPS (0.99)	- 899.8 APWPPS (-1.58*)	0.902	33.2***	1.59
(iii)	NI ADULT SHEEP SLAUGHTER SLASN	= -782 (-0.37)	+ 0.154 KASNL (2.96*)	+ 14.4 WSN (1.04)	- 186.6 APLPPN (-1.35)	+ 708.6 APPBPPN (1.62)	0.481	6.3**	2.85
(iv)	SI ADULT SHEEP SLAUGHTER SLASS	= -782 (-0.45)	+ 0.149 KASSL (2.27*)	+ 18.6 WSS (3.08*)			0.532	6.9**	2.93
(v)	NI LAMB DEATHS DLN	= 478 (0.91)	+ 0.0122 LMN (0.75)	+ 5.1 WSN (1.45)	- 362.1 APLPPN (-2.45*)	+ 434.3 APPBPPN (1.40)	0.445	2.8*	2.51
(vi)	SI LAMB DEATHS DLS	= 618 (3.70**)	+ 0.0067 LMS (1.18)	+ 0.78 WSSL (1.43)	- 112.1 APLPPS (-3.45**)		0.673	6.8**	1.55
(vii)	NI ADULT SHEEP DEATHS DSN	= 645 (1.59*)	+ 0.0295 KASNL (2.29*)	+ 4.66 WSN (1.70*)	- 406.5 APMPN (-2.49*)		0.615	5.4**	2.65
(viii)	SI ADULT SHEEP DEATHS DSS	= -14.1 (-0.02)	= 0.049 KASSL (1.82*)	+ 0.89 WSS (0.94)	- 47.8 APWPPS (-0.52)		0.789	12.5**	1.51