Commercial Vehicle Usage and Forecasting – Stage 2: National Freight Traffic

L. Jewell, F. O'Riley, W. Wallace
Opus International Consultants, Wellington, New Zealand

A. Stroombergen
Infometrics Ltd., Wellington, New Zealand

Land Transport New Zealand Research Report 330

ISBN 0-478-28743-7
ISSN 1177-0600

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PO Box 2840, Waterloo Quay, Wellington, New Zealand
Telephone 64-4 931 8700; Facsimile 64-4 931 8701
Email: *research@landtransport.govt.nz*
Website: *www.landtransport.govt.nz*

Jewell, L.[1], O'Riley, F.[1], Wallace, W.[1], Stroombergen, A.[2] 2007. Commercial Vehicle Use and Forecasting – Stage 2: National Freight Traffic. *Land Transport NZ Report Number 330.* 236 pp.

1 Opus International Consultants, PO Box 12 003, Wellington, New Zealand
2 Infometrics Ltd., PO Box 10068, Wellington, New Zealand

Keywords: commercial vehicles, exports, forecasting, freight, gravity model, goods, heavy vehicles, IO, imports, national freight model, New Zealand, SATURN, regions, traffic flows.

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Acknowledgements

Thanks are due to Geoff Butcher of Butcher Partners for his peer review of the input-output analysis report presented in Appendices A and to Tim Kelly of Tim Kelly Transportation Planning Ltd and Steve Moynihan for the peer review of the Commercial Vehicle Usage and Forecasting – Stage 2: National Freight Traffic report.

Abbreviations

AADT: Annual Average Daily Traffic
EDA: Equivalent Design Axles
GDP: Gross Domestic Product
GVW: Gross Vehicle Weight
HMV: Heavy Motor Vehicle
HS Harmonised System
IO: Input-Output
LP: Linear Programming
MAF: Ministry of Agriculture and Forestry
MOT: Ministry of Transport
NKT: Net Tonne Kilometres
NZAA: New Zealand Automobile Association
NZR: New Zealand Railways
NZRC: New Zealand Railways Corporation
NZRL: New Zealand Rail Limited
OD: Origin–Destination
OLS: Ordinary Least Squares
PPI: Producers' Price Index
RUC: Road User Charge
TNZ: Transit New Zealand
VKT: Vehicle Kilometres Travelled

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Executive summary

The purpose of the research was to assist in regional transport modelling and long-term road planning by defining the amount of commercial traffic on the major highways in New Zealand, giving trip numbers at the boundaries of each region, and the likely destination and routes taken by these trips within the region. The research proposal was based on the project being delivered in two stages.

The output for Stage One was the research report 'Commercial Vehicle Usage and Forecasting', completed in February 2002. The report reviewed methods to predict trip generation by commercial vehicles within a region. The report concluded that the most appropriate method for predicting trip numbers in New Zealand regional transport models was to link trip numbers to the numbers of workplace employees in the various work type categories within a transport model zone. The study proposed a set of multipliers be used with employment statistics to give overall commercial vehicle trip numbers.

A supplementary validation exercise was carried out to confirm the accuracy of the multipliers. The exercise involved cordoning a zone and setting up traffic counters to record all inward and outward traffic movements. Applying the multipliers to the workplace employment statistics for the zone should theoretically produce trip numbers that agree reasonably well with the counted numbers. Analysis of the traffic counts resulted in a revised set of multipliers applied to workplace employee numbers to predict heavy commercial vehicle trip generation.

Stage Two of the Commercial Vehicles Usage and Forecasting Research Project was spread over two years (2004–2005 and 2006–2007) to allow sufficient time and budget for three independent models to be researched. The Stage Two research was broken down into five major components of work:

- literature review and New Zealand freight overview,
- input-output (IO) analysis model,
- SATURN traffic model,
- gravity model, and
- model comparisons and recommendations.

The literature review included research on national freight models by overseas researchers, and papers on New Zealand freight movement. Information and statistics from the literature review were used to derive appropriate inputs to the models as required.

The three models are essentially three ways of looking at the same problem. Three matrices were derived from each model, giving a robust approach and a means of calibrating the results.

The objective of the IO analysis was to derive an origin-destination (OD) matrix of truck trips for the fourteen transit regions using regional IO tables. This was the first use in New Zealand of this approach, as it is only recently that economists have divided national statistics in this regard into regional statistics.

The objective of the SATURN modelling was to use observed traffic link count information to estimate an OD trip matrix for inter-regional heavy vehicle movements in New Zealand. The form of the estimated OD trip matrix was the same used in the IO analysis. To estimate the OD trip matrix from traffic counts, the computer software package SATURN was used. SATURN generated an OD trip matrix that showed some expected trends, such as low heavy vehicle movements between islands.

The aim of the gravity modelling section of the research was to construct a gravity model that could be used to estimate and forecast the level of inter-regional heavy vehicle traffic in New Zealand. A series of gravity models that were statistically significant were generated. We can be confident that approximately 69–76% of the variation in traffic counts can be explained by the gross domestic product (GDP) and distance (time taken) variables, which is within the range determined in empirical gravity modelling work.

Calibration of the results with actual traffic counts revealed that there are other factors causing variation in the gravity model for some regions. As the model is limited to examining two variables (GDP and distance), other factors such as a strong rail or shipping presence, or transportation/distribution hubs may create distorted results that are not picked up in the model. The results from the calibration also highlighted that the relative size of the regional economies can cause the model to give unsatisfactory results when comparing economies that are significantly different in size.

All three methodologies were used to derive inter-regional counts of commercial vehicle freight movements in New Zealand.

The variability of the results between the three models illustrates that taking only one overall approach is probably not the correct strategy for developing a national inter-regional freight model. A combination of gravity modelling and IO analysis is more likely to yield a representative model of inter-regional commercial vehicle flows.

Abstract

This report presents the findings of the second stage of research looking at regional transport modelling and long-term road planning. The research aimed to define the amount of commercial traffic on the major highways in New Zealand, giving trip numbers at the boundaries of each region, and the likely destination and routes taken by these trips within the region.

Stage One was completed in February 2002. Stage Two was broken down into two parts which were completed in the 2004–2005 and 2006–2007 research programmes.

The Stage Two research can be broken down into five major components of work:

- literature review and New Zealand freight overview,
- Input-output analysis model,
- SATURN traffic model,
- gravity model, and
- model comparisons and recommendations.

The three models are essentially three ways of looking at the same problem. Three matrices were derived from each model, giving a robust approach and a means of calibrating the results.

The goal of this research project is to look at the potential methods for creating a national freight model, and to make recommendations on how these methods can be used either singly or in combination to create a robust national freight model.

1. Introduction

1.1. Background

The Commercial Vehicle Study proposal was submitted in the 2000/2001 Transfund research programme. The purpose of this research was to assist in regional transport modelling and long-term road planning by defining the amount of commercial traffic on the major highways in New Zealand, giving trip numbers at the boundaries of each region, and the likely destination and routes taken by these trips within the region.

The research results can be used as a starting point to develop more complex inter- or intra-regional commercial vehicle models, and as preliminary analysis to determine starting values. Models are needed to predict future freight traffic growth.

The research proposal was based on the project being delivered in two stages as follows:

- Stage One: trip numbers generated by traffic zones in regional models (internal to cities/towns);
- Stage Two: national freight traffic (between cities/towns).

Stage One was completed in February 2002 (Moynihan 2002). A supplementary validation report was proposed and undertaken to confirm the model multipliers and was completed in August 2004 (Moynihan 2004).

Stage Two was broken down into two parts to be completed in the 2004/2005 and 2005/2006 Land Transport New Zealand research programme. A literature review and research of intra-regional freight movement in New Zealand was undertaken in 2004/2005. Gravity modelling and SATURN analysis was programmed for 2005/2006 and was extended into the 2006/2007 research programme to allow completion.

1.2. Overview of Stage One

Opus International Consultants completed the research report 'Commercial Vehicle Usage and Forecasting' in February 2002. The report reviewed methods of predicting how many commercial vehicle trips would be generated within a region. The report concluded that the most appropriate method for predicting trip numbers in New Zealand regional transport models was linking trip numbers to the numbers of workplace employees in the various work type categories within a transport model zone. The study proposed a set of multipliers be used with employment statistics to give overall commercial vehicle trip numbers.

A supplementary validation exercise was carried out to confirm the accuracy of the multipliers. The exercise involved cordoning a zone and setting up traffic counters to record all inward and outward traffic movements. Applying the multipliers to the

workplace employment statistics for the zone should theoretically produce trip numbers that agree reasonably well with the counted numbers.

Analysis of the traffic counts resulted in a revised set of multipliers applied to workplace employee numbers to predict heavy commercial vehicle trip generation.

1.3. Stage Two approach

1.3.1 Introduction

Stage Two of the Commercial Vehicles Usage and Forecasting Research Project has been spread over two years to allow sufficient time and budget for three independent models to be researched.

The Stage Two research can be broken down into five major components of work:

- literature review and New Zealand freight overview,
- input-output (IO) analysis model,
- SATURN traffic model,
- gravity model, and
- model comparisons and recommendations.

The literature review has included research on national freight models by overseas researchers and papers on New Zealand freight movement. Information and statistics from the literature review were used to derive appropriate inputs to the models as required.

Essentially, the three models are three ways of looking at the same problem. Three matrices were derived from each model, giving a robust approach and a means of calibrating the results. For the purpose of this project, a heavy vehicle is deemed to be a vehicle with a gross weight over 3.5 tonnes.

The goal of this research project is to look at the potential methods for creating a national freight model, and to make recommendations on how these methods can be used either singly or in combination to create a robust national freight model.

1.3.2 Input-output analysis

IO analysis uses the values of production and consumption in each region to determine the flow of goods between regions. IO analysis is widely used overseas for large-scale freight modelling. The process involved is one of gathering information from statistical records on the values of production and consumption in the different regions or cities, and evaluating the interplay between these. The values of commodities flowing between centres can then be assessed. Values are then converted to volumes or weights, and then to vehicle numbers. When values are converted to weights, no information about the mode of transportation is available, as the IO analysis looks at regional production and consumption as a whole. Therefore, goods transported by other modes such as rail and shipping need to be factored out.

This will be the first use in New Zealand of this approach as it has been only recently that economists have divided national production statistics in this regard to regional statistics. This research will therefore provide a valuable contribution to the understanding of freight movement in New Zealand. As such, the IO analysis is presented as a stand-alone paper, as well as part of the overall project report. The IO analysis and report was prepared by economics research company Infometrics and is included in Appendix A.

1.3.3 SATURN modelling

This approach uses the software SATURN ME2 to evaluate trip patterns from the traffic counts on selected links. This method simply analyses and attempts to rationalise the traffic counts. The information used to carry out this analysis was:

- a network of nodes (regions) connected by a number of links (major highways),using the simplified Transit network for the model;
- count information on links of the state highway network; and
- a base/starter origin–destination (OD) trip matrix used as a starting point for the iterative process in developing an OD matrix from count information.

The first step in the modelling process is to enter the simplified network and initial OD trip matrix into SATURN. The model is then run to check for errors. Once the model is running successfully within SATURN, the ME2 program is set up by introducing observed count information for each link and defining the level of change from the initial OD trip matrix to the traffic count information.

The basic mechanics of the ME2 program compare the modelled initial matrix flows with the traffic count information on a specific link. The difference in flow between the two is noted and a factor is then applied to the initial matrix flow to adjust it to match the traffic count information better. The factor either lowers or raises the matrix flows so as to get a better similarity to the count information, while still satisfying the consistency of flows across the network. This process is continued until the resultant OD trip matrix has reached equilibrium. The final product is an estimated OD trip matrix that is essentially a product of the count information entered into the ME2 program.

1.3.4 Gravity modelling

Gravity modelling uses the economic attributes of cities and the distance of State Highway (SH) links to estimate freight trips between regional centres.

Economists have adapted Newton's theory of gravity to apply it to modelling social interactions such as migration, tourism, foreign direct investment and trade flows. In this research, heavy vehicle traffic flows between regions have been modelled. The idea behind the gravity model is that larger regions will attract more people, generate more trade and more goods movement than smaller regions, and regions that are closer together will have a greater attraction. The augmented gravity model incorporates both of these features.

'Masses' that can be used to model the traffic volume include regional gross domestic product (GDP), which represents the output of each region; population, representing the productive capacity of each region and the demand for goods; and additional variables such as labour participation and unemployment rates.

The gravity model is based on traffic count data and regional boundaries over 1997–2004 and tests high, medium and low traffic count estimates. These data are used to generate multipliers for the gravitational formula. This method makes gravity modelling a good candidate for developing a model to predict future traffic counts by inputting future estimates of regional GDP and population.

2. Literature review

2.1. Introduction

A literature review was undertaken on papers relating to New Zealand freight transportation and international studies on national freight modelling. A search of the internet and library databases was undertaken by the Opus Information Centre, which has access to a variety of databases and search facilities which allow it to search for papers and reports in journals, conference proceedings, research publications and studies.

The literature review involved:

- internet searches for research papers on national freight modelling,
- reviewing heavy vehicle research papers,
- reviewing New Zealand transportation papers, and
- gathering statistics from government websites and annual reports of freight companies.

The literature review is structured as follows:

- New Zealand heavy vehicle papers;
- agricultural freight generation;
- logging freight generation;
- national freight modelling.

2.2. New Zealand heavy vehicle papers

2.2.1 Profile of the heavy vehicle fleet (Baas 1999)

This report is a collection of quantitative information about heavy vehicle freight. The report was a first attempt to summarise detailed information on the New Zealand heavy vehicle fleet. It was prompted by the need to determine why New Zealand has a high proportion of heavy vehicle rollover crashes compared to other similar countries, and the need for background information for assessing proposed heavy vehicle weight and dimension changes.

The data was primarily taken from motor vehicle registration and road user charges (RUC) data. Information was also taken from vehicle count and Land Transport Safety Authority data. Most of the information presented is based on 1997 data, with some comparisons to previous years.

The report makes the following assumptions:

- The level of enforcement of RUCs is high, given that heavy vehicles are being stopped on average once every three months.
- Five percent of hubometers have been shown to underestimate distance travelled. The extent of the under-recording was unknown.
- Surveys have shown that about 11% of licences are underpaid.
- Vehicle payloads may differ from the assumed payloads; the latter were based on an average loading of 50% full loads and average loading tare weights for trucks of 33% of their gross vehicle weight (GVW) limit and trailers 25% of their GVW limit. Consequently, some payload statistics given as tonne-km may be inaccurate.
- The analysis of RUC data for 1997 assumed that all Type 1 and 2 vehicles for which '4 tonne or more' licences were purchased and all other vehicles with '30 tonne or less' licences are heavy vehicles.

Some useful tables in the report include:

- estimated distance travelled by vehicle combinations,
- distance travelled by industry code,
- estimated number of single trucks and combinations (1997),
- number of vehicles by industry code (1997),
- number of heavy vehicles (1997),
- total payload carried by heavy vehicles (1997),
- payload carried by industry code (1997),
- New Zealand surface freight in million tonne-km, and
- freight transported (all modes) by industry sector (1996).

Some useful graphs in the report include:

- heavy vehicle distance travelled by RUC vehicle type (1997),
- distance travelled by trucks by weight and distance,
- number of vehicles by annual distance travelled and RUC licence weight,
- payload carried versus payload weight and distance travelled,
- payload carried by RUC vehicle type, and
- payload carried by trailers for different weight groupings and RUC types (1997).

2.2.2 Heavy vehicles research project (Transit New Zealand 2001)

This report is part four of seven investigating the feasibility of changing the mass and dimensions of heavy vehicles in New Zealand. It specifically looks at transport economics and road freight industry economics.

The project came from the Transit Heavy Transport Routes research project undertaken in 1992–96. It deemed that it was not feasible to upgrade the entire road network to accommodate substantially longer vehicles. Therefore, Transit looked at following two scenarios:

- Scenario A: The truck fleet would be able to operate with the existing fleet (with no increase in dimension), but would be allowed to operate with greater loads.
- Scenario B: The truck fleet would be allowed increases in both weight limits and truck dimensions, on selected routes only.

The study had to consider various components regarding safety, bridge structures, pavement deterioration and (for Scenario B) geometric issues with the greater dimensions. A full economic analysis was undertaken for both scenarios.

The study identified small cost savings for the economy from both scenarios; Scenario B showed greater potential savings for the freight industry within New Zealand.

An offshoot from the analysis was the finding that certain truck configurations with greater dimension and weight limits (such as B-trains) will not be popular if current RUCs are maintained. These charges are so high that any cost savings from the configuration are lost.

Transit New Zealand 2001 also has useful information on freight movements in vehicle kilometres travelled (VKT) and net tonne-kilometres (NTK). These values are gross values and include vehicle tare weight. General trends of freight growth within New Zealand were also provided in the report.

2.3. Agricultural freight generation

2.3.1 Statistics New Zealand

Yearbook figures

The agriculture chapter in the Statistics New Zealand 2002 yearbook (Statistics New Zealand 2002a) provides information on the following topics:

- farmland use by regional council area as at 30 June 1999,
- distribution of livestock as at 30 June 1999,
- comparison of meat produced from 1992 to 2000,
- livestock slaughter at meat export works and abattoirs from 1992 to 2000, and
- shipping weight of export meat production from 1992 to 2000.

Land use (Statistics New Zealand 2002b)

This web page gives an overview of changing land use patterns for year ended 30 June 2002:

- Grazing and arable land use has decreased by 12% since 1994 to 12.0 million hectares in 2002.
- Horticultural land use has increased by 6% since 1994 to 110 000 hectares as at 30 June 2002.
- More land is being used for horticulture as the area planted in wine grapes continues to increase.

- The area planted in production forest has increased by more than a quarter since 1994 as marginal farming land is converted.

Agricultural production (Statistics New Zealand 2000)

This article identifies and discusses some of the national and regional changes that are apparent upon examining the 1999 agricultural production statistics. Farming patterns are changing at a regional level according to the 1999 agricultural production survey. A move away from sheep and beef farming to dairy, deer and forestry activities is reasonably well recognised at a national level. However, at the time of writing, the same amount of information has not been available at a regional level. The article provides a 5–6 year regional comparison for sheep, cattle, deer and pig numbers prior to 1999.

Census results (Statistics New Zealand 2003b)

This report contains the final results from the 2002 Census of Agriculture, Horticulture and Forestry, and other statistics related to agriculture. It provides readers with background information on the agricultural industry, and detailed analysis and commentary on the statistics.

Summary tables provide a comparison of the following statistics between June 1994 and 2002:

- livestock numbers by region,
- land use by region,
- net area planted in fruit by region,
- selected vegetable crops by region, and
- forestry by region.

2.3.2 Rural transport studies (King et al. 1982a & b)

The purpose of these studies was to provide information about the amount of travel associated with various types of rural land use and to consider the effect of the Road User Charges Act on rural traffic.

The study focuses mainly on trips (both by private light vehicles and heavy vehicles) within the study regions selected (Southland, Ashburton, Wairoa and Matamata), rather than between regions.

The data in these reports are somewhat dated (late 1970s); however, it contains useful information on truck payloads and regional trends in agricultural transportation.

King et al. 1982a contains information on:

- average tare and gross weights for commercial livestock vehicles;
- a summary of results from roadside weighing including average vehicle weights and percentage of capacity;
- a summary of transport demand from the regional dairy companies, freezing works, stockyards and wool scourers. This section also considers the mode of transport between farms, dairy factories, freezing works and ports.

King et al 1982b contains information on:

- an overview of trends in rail use, percentage of road freight and contribution to trips/weight of freight by different types of farming;
- average quantities of commodities transported to and from farms in tonnes per 1000 hectares per annum;
- destinations of various farm products for each region in the study;
- summaries of the road/rail split and average haulage distance; and
- a comparison of the number of trips and tonnes for farm and forest production.

2.3.3 Other sources

- The Ministry of Agriculture and Forestry (MAF) map (2007) provides areas of land use for pastoral, dairy, indigenous forest and planted forest.
- The farm monitoring reports (MAF 2004) contains a collection of reports providing farm numbers and stock numbers for different regions.
- A newspaper report (Morgan 2005) provides forecasts for agricultural exports over the coming years.

2.4. Logging freight generation

2.4.1 Jenkins (1996)

Jenkins et al. (1996) attempted to determine the relationship between the area of standing forest in a particular part of New Zealand and the traffic expressed as Equivalent Design Axles (EDA) that would be generated by the forestry operations. A computer model was developed to predict the heavy traffic flows produced by the operations arising from a 30-year planning period of production forest for an area served by a road network.

A notional section of road servicing a typical forest area was analysed, based on the procedures set out in the Transit New Zealand (TNZ) *Project Evaluation Manual* (Transit New Zealand 1991). The effect of forestry operations on the road network was studied, particularly the effects of logging traffic.

The model developed was sensitive to the harvesting stage, as the time when this stage will take place can only be established by information in current forestry management plans. A default optimum time of harvest was used and the productivity of the forest was calculated. The model was then used to establish the number of trips and therefore the number of EDAs that will result from harvesting the forest.

The results of the economic analysis indicated that although logging traffic appears to have a relatively high frequency on a particular route, it generally only forms a small part (mostly less than 5%) of the overall traffic stream on a major strategic road. Logging traffic has this apparent impact because it travels constant routes and to the far ends of a road network. The impacts are more significant on rural strategic roads, where logging traffic may account for up to 10% of the overall traffic flow, and in some cases, may account for 20% to 25% of the pavement's design EDAs in a very short time.

While this increased flow is economically significant, it is relatively temporary and cannot be classified as a major influence on roading economics, as a rural strategic road will not be used continuously as a logging route, but only for 5–10 years out of a 20–25 year forestry cycle.

2.4.2 Schnell (1992)

Schnell (1992) reviewed the proportion of roading costs that the forestry industry currently pays through the central government and local authority taxes. Data were collected from a poll of members representing ownership of approximately 85% of the national exotic forest estate. Responses were returned for approximately 78% of the total stocked area of exotic forestry plantations. Respondents were asked to give actual 1990 production figures, by district of origin, along with projections for the year 2000.

The results indicated that forest industry's use of public roads was estimated to increase in terms of hauled tonnage during the period 1990–2000 by an average of approximately 33% on State Highways and 128% on district roads. Most regions were estimated to experience an increase in road usage with the exception of the Bay of Plenty and Hawkes Bay, which were predicted to decline marginally. Road use on the West Coast, Gisborne and Northland was estimated to more than double by 2000, while Nelson/Marlborough, Auckland and Canterbury were predicted to experience increases on the order of 150–180%.

2.5. National freight modelling

Bolland et al. (2005) researched recent long distance, high tonnage freight movements throughout New Zealand. The report presents a snapshot of freight movements in the year 2002. The objective of the report was to:

- develop estimates of the main (non-urban) freight movements within New Zealand, by commodity, tonnage, mode and OD;
- relate these movements to the location of processing/export facilities in the case of primary flows: and
- relate them to population and industrial production in the case of manufactured and consumer goods.

The report presented a regional road OD matrix and combined this with a rail matrix to form a total land-based matrix. The main findings of the report were:

- Most goods are transported by road with a 83% share of tonnage and a 67% share of tonne-km. Rail has an approximate 13% of total tonnage and 18% of total tonne-km; costal shipping, 4% of tonnage and 15% of tonne-km.
- Auckland, Waikato and Bay of Plenty account for the production and attraction of over half of road and rail freight. This includes both inter- and intra-regional freight.
- Higher rail tonnages correspond to locations of major industrial plants, mines and ports.
- A significant proportion of all freight cannot be easily classified into specific commodity groupings.
- The primary industries of agriculture and forestry are the largest originators of freight. The transport of logs, milk and livestock account for a significant share of total freight movements.

3. Long haul freight in New Zealand

3.1. Introduction

The three principal modes of transportation available for long haul freight services in New Zealand are road, rail and shipping.

Freight transported throughout the country can be broadly separated into three categories:

- export goods delivered to ports,
- import goods delivered from ports,
- goods produced or processed in New Zealand for domestic use or consumption.

Each of these categories has unique demands on the transportation industry.

Industries involved in export trade are spread throughout the country based on the availability of primary resources, climate and labour resources. Up to 99% of export goods by weight are transported to international markets by sea. The remaining 1% of export goods are generally high-value goods transported by air freight. Therefore, export goods tend to be progressively collected at various hubs throughout the country until they are transported to a major port. This leads to significant inter-regional freight transportation, which is likely to increase in the future because of on-going efficiencies in logistics, competition between major ports, and ports specialising in handling specific types of goods.

Transporting imported goods results in comparatively low inter-regional transportation, as the majority of imports tend to be delivered directly to the port of final destination. Most regions in New Zealand are serviced by some form of port, with the exception of Manawatu/Wanganui. The Ports of Auckland receive the largest amount of imports by value (Marsden Point receives the most by weight because of the large quantities of imported fuel). The Ports of Auckland estimate that 80% of containers unloaded are delivered within a 30 km radius of the port.

Goods transported throughout New Zealand for domestic consumption are the most difficult to generalise in terms of demand for long-haul freight services or preferred modes of transportation.

Certain types of goods are almost exclusively carried by one mode of transportation on an inter-regional basis. For example, bulk quantities of heavy goods such as logs and refined fuels tend to be carried by rail and shipping respectively. Other goods are transported by all three freight modes, with the relative proportions changing from year to year based on several factors including cost, timetables, speed of delivery, reliability and availability of services.

The companies that provide services for each mode of transportation vary significantly in terms of corporate structure. Toll Rail is the only company providing rail freight services in New Zealand and it has exclusive access to the rail network. Pacifica Shipping is the only New Zealand company operating a dedicated coastal freight service between domestic ports and a few other companies operate exclusively on Cook Strait. New Zealand companies carry 85% of domestic shipping with the remainder transported by international companies. Road freight services have numerous companies varying in size from family businesses through to large multi-national companies.

Inter-regional modelling of commercial vehicle numbers in New Zealand needs to consider the three major modes of freight transportation services to assess the likely impact on road transportation services.

This section provides an overview of the three major modes of transportation in New Zealand. Tables of statistical information are summarised where available. The availability of detailed information is limited because of commercial sensitivities.

3.2. Road freight

3.2.1 Introduction

New Zealand's road network totals approximately 93 000 kilometres. Of this, nearly 11 000 kilometres are designated as State Highways. These are managed by TNZ. State highways form the major strategic links and account for just under half of the 36 billion vehicle-kilometres travelled each year. The remainder of the network is referred to as local roads. These are managed by Territorial Authorities.

Heavy vehicle road usage can be measured in terms of VKT and NKT, which exclude the tare weight of the vehicle. The comparison between heavy vehicle VKT and NKT reflects differences in the average weight carried per vehicle.

Table 3.1 provides a road use intensity summary for each region during 1999.

Table 3.1 Road use heavy vehicle intensity summarised by region for 1999.

Region	VKT (millions)	NKT (millions)
Northland	38	418
Auckland	129	1416
Waikato	110	1627
Bay of Plenty	57	845
Gisborne	8	109
Hawkes Bay	28	328
Taranaki	27	354
Manawatu/Wanganui	63	743
Wellington	46	528
Nelson/Marlborough/Tasman	20	222
Canterbury	83	971
West Coast	15	170
Otago	46	615
Southland	25	329
NEW ZEALAND	696	8675

Note: figures taken from Transit New Zealand 2001.

The Auckland Region has the highest heavy vehicle VKT at 129 million vehicle-km per year. Although Auckland only has 8.6% of the total road length, it makes up 19% of the heavy vehicle VKT.

The Waikato Region has the highest NKT at 1,627 million tonne-kilometres (tonne-km) per year. However, in terms of weight intensity, the Bay of Plenty has the highest intensity at 214.8 thousand tonnes per kilometre, roughly double the New Zealand average of 106.5 thousand tonnes per kilometre. Other regions with high weight intensities are Auckland, Waikato, Taranaki and Wellington.

In urban dominated regions such as Auckland and Wellington, this reflects the high intensity associated with port and industrial activities. In the Bay of Plenty, Waikato and Taranaki, this is likely to reflect high demand from forestry and dairying activities. The Gisborne Region has both the smallest heavy vehicle VKT and NKT.

A range of pressures are being placed upon the network, including traffic congestion in Auckland and accelerated pavement deterioration associated with heavy traffic growth. Substantial investment is planned to relieve congestion in Auckland.

3.2.2 Regional analysis

In general, the state highway network has the ability to meet increasing demand for freight transportation in the near future. Future growth will reduce the level of service for other road users and require additional maintenance expenditure. The state highway network in some urban areas has limited capacity, which restricts movement of road traffic either during regular commuter or public holiday periods. A summary of current regional issues is discussed below:

Northland: Northland's road network comprises 70% of unsealed roads compared to a national average of 30%. The network requires significant upgrading to provide an efficient network. This is especially true for forestry areas, where regional funding is currently allowing upgrading of key harvesting routes. Northland's subgrade materials are generally poor and contribute to the relatively high cost of road maintenance. Rail access to the major deep water port in Whangarei is being investigated in order to assess the viability of providing rail access for port traffic.

Auckland: The Auckland region has the worst congestion problems in the country, which has a significant impact on transport efficiency. Congestion affects both the motorway and primary arterial routes. Planned improvements will address critical points such as access to the Port of Auckland, and improvements to the Central Motorway Junction. Progress on improvements is greatly affected by local and central government, as well as the consent procedures of the Resource Management Act.

Waikato/Coromandel: A combination of tourism, development and forestry/dairying pressures are steadily increasing demand on the roading network.

Several pressure points are located on the existing highway network, including the Wairau River Bridge (SH25 near Thames) and access to key holiday areas in the Coromandel.

The Port of Tauranga has raised concerns regarding the fact that it is the only port without direct state highway access (to part of the port).

Central and Eastern North Island: Across the Central and Eastern North Island, the increase in forestry traffic is putting pressure on the roading infrastructure. The alternatives for carrying logs are limited in a number of locations. The likely tonnages of logs on the East Coast railway (Napier to Gisborne) would result in modest savings for road maintenance costs.

Wellington: Congestion during peak commuter hours and weekends occur on the urban sections of SH1 and SH2 near Wellington. The critical routes leading into the region are also susceptible to closure after extreme weather events.

When considering long-term improvements in the road network, planners are heavily influenced by local and central government.

South Island: The South Island roading network has no significant congestion problems because of lesser growth in traffic, tonnages and population. Forestry harvesting is projected to affect the Nelson, Marlborough, Otago and Southland areas in the future.

In recent years, South Island areas are experiencing a progressive conversion of pastoral farming to dairying, especially in Southland. This results in additional tonnages and a higher frequency of heavy vehicles visiting farms.

The development of small land holdings closer to urban areas is raising the demand for sealed roads particularly in growth areas such as Nelson and Central Otago.

Tourism is a major growth area requiring continued higher standards of access to key tourism destinations such as Queenstown and the Milford Sound.

Access to key ports is adequate at present. However, future increases in forest harvesting are likely to place pressures on existing road access to the ports of Nelson and Otago. Forest harvesting places particular pressures on otherwise lightly trafficked routes needing investment in road strengthening (both sealed and unsealed) and development of key bridge assets. This places financial burden on Territorial Authorities.

3.2.3 Road summary

The overall road network is in good health. This review suggests that no major issues that impinge upon existing maintenance practices and renewal programmes. However, a range of pressures are being placed upon the network including traffic congestion in Auckland, and the wear and tear associated with heavy traffic growth, particularly in the forestry sector. Substantial investment is planned to relieve congestion in Auckland and Wellington. Beyond congestion in the two main centres, the review has also identified forestry as having a major impact on the road network.

3.3. Rail freight

3.3.1 Historical background

Construction of the railway network began in the late 1800s. The railway was operated as an integrated freight and passenger operation controlled by the Railways Department until 1982. The Cook Strait Interisland ferry service was introduced in 1962.

The New Zealand Railways Corporation (NZRC) was formed in 1982 and rail operations were extensively restructured to conduct business more efficiently.

In 1983, regulations governing the transportation of goods by road were removed and the rail sector had to compete against a deregulated road sector.

In 1990, New Zealand Rail Limited (NZRL) was incorporated as a limited liability company wholly owned by the Government in preparation for privatisation. New Zealand Rail was privatised in 1993 and the new owners formed Tranz Rail Holdings Limited.

In 2000, Tranz Rail was significantly restructured, which included selling off the long-distance passenger services and outsourcing non-core business functions such as track and rolling stock maintenance. The company was split into three business units:

- Rail Services Group,
- Distribution Services Group, and
- The Interisland Line.

Tranz Rail experienced financial difficulties in 2003 and was on the verge of bankruptcy when it was sold and split into two companies. The Crown negotiated an agreement with Australian company Toll Holdings to ensure New Zealand had an operating rail network. Toll Holdings acquired a majority shareholding (around 85%) in Tranz Rail, renaming it Toll NZ. The Government agreed to buy back the rail infrastructure from Toll. A new crown-owned entity, OnTrack, was formed under NZRC to own and manage the rail infrastructure from 1 July 2004.

3.3.2 State of the existing network

OnTrack has taken over the ownership and maintenance of the rail network, and is committed to addressing the most critical problems in the rail network. A summary of the key issues faced by OnTrack are listed below:

- The rail network has suffered from low levels of asset replacement, which has affected the quality and reliability of services.
- The quantity of freight carried on rail is increasing.
- Parts of the rail network, usually tunnels, are not capable of taking the longer or higher containers that are increasingly being used internationally.
- Investment to specific rail lines based on future rail traffic should be allocated.
- An access charge regime for Toll's use of the network needs to be developed.
- New rail heads need to be constructed to ports (Marsden Point) and other large manufacturing plants (dairy).

The quantity of freight carried on the network has been increasing steadily, with 14 million tonnes carried in the June 2003 financial year. A number of growth industries such as coal, forestry and dairy will increase demand for rail services in the immediate future. The increasing use of containers internationally will also make rail a more attractive option in the future.

3.3.3 Regional demand and constraints

Northland: Northland is set to experience a large increase in wood supply over the next five years as many of the exotic forests are reaching maturity and are ready for harvest. Most of the logs harvested in the Northland region need to be double-handled by trucks because of a lack of rail access to the deep water port at Marsden Point. Logs are loaded onto trucks at the forest location and are delivered to nearby railheads. The logs are then transported by rail over a relatively small distance to Whangarei, where they are reloaded onto trucks for transport to the deep water port. The Auckland to Whangarei line would require upgrades to permit an increase in rail traffic.

Waikato: The Broken Hill Proprietary Company (BHP) Ltd. steel mill at Glenbrook sends large quantities of export steel via rail to the Port of Tauranga and finished products throughout New Zealand. Large quantities of coal are also delivered from Solid Energy's mines at Rotowaro and Kimihia.

Bay of Plenty: The Port of Tauranga has wharves on both sides of the harbour. Rail access and standing room for wagons at the port are limited. A log transfer station has been built recently at Kawerau to enable logs to be stockpiled away from the port; shuttle trains will be used to transport logs to meet shipping schedules. The Bay of Plenty forests and major processing plants at Kinleith, Kawerau and Whakatane are generally well served by the rail network, which has traditionally transported a high proportion of logs and other forest products, both for export through the Port of Tauranga and domestically throughout the country.

Gisborne: The East Coast is also set to experience a large amount of wood from mature forests. However, because of the location of forests relative to the railhead and the proximity of the Gisborne Port, the majority of the logs are not likely to travel by rail outside the region. Rail transport of processed wood products on the line from Gisborne to Napier may increase somewhat. The Gisborne Line is a long winding route that is prone to slips, wash-outs and floods. Only essential maintenance has occurred in recent years because of the limited train services and very low levels of tonnage generated on the line.

Hamilton–Palmerston North: This section of the North Island Main Trunk Line is a single line with curves and grades which restrict speed and travelling times. Capacity constraints apply at night, especially on the section north of Raurimu. This could be overcome in the future with additional double-tracked sections or passing loops.

Taranaki: A rail shuttle between Whareroa and Stratford transports 0.6 million tonnes of bulk milk per year for Fonterra. Tunnel clearances limit the ability to transport 9'6" containers.

Manawatu: Restricted clearances through the Manawatu Gorge tunnels limit the ability to transport 9'6" containers.

Christchurch–Picton: The track is a single line route with no alternatives connecting Christchurch to the rail ferries. The steep grade out of Picton limits the capacity of each train.

Midland Line and West Coast Coal Route: Coal volumes on the Midland Line have increased from 0.2 million tonnes in 1976 to 2.1 million tonnes in 2003. Solid Energy's 15-year plan will see these volumes grow to 4 million tonnes per year by 2009. The current strategy is to mine to the capacity of the transport infrastructure.

Otago/Southland: The dairy industry in the South Island has experienced rapid growth over recent years. Limited rail access to the major processing plants has restricted the transportation of dairy products by rail. Fonterra's largest factory at Clandeboye has no rail access. Currently, most products are transported by road, either direct to/from the factory. Products travelling by rail are loaded into trucks for the short trip between the factory and the rail yard at Temuka.

Recent and projected rapid growth rates at Clandeboye (currently around 19% per annum) are creating pressure on the road infrastructure used to service the site. Considerable scope still remains for additional dairy conversions in the surrounding areas. Fonterra proposes to expand the capacity of the Clandeboye factory from the current 8.3 million litres of milk per day to 14 to 15 million litres per day by constructing a third milk powder plant at Clandeboye.

Toll Rail has worked with Fonterra and the local council over a number of years to investigate various solutions to extend the rail track to the factory, but have been unable to justify the significant investment required.

3.3.4 Trends in rail operations

Traditional rail freight operations are complex and inefficient. Making a train required complex and dangerous shunting procedures (shuffling different wagons laden with different cargoes from various points within a rail yard). Once the rail journey began, cargoes were dropped off and picked up along the way, and trains were often disassembled and reassembled at major sidings. The complex operations often left customers dissatisfied with rail services because of delays and freight mix-ups.

The current trends are to run fixed capacity, point-to-point scheduled services using four types of train configuration:

- container trains (containerised freight),
- pack trains (consolidated general freight),
- bulk trains (coal, logs or dairy produce), and
- block trains (petroleum and fertiliser).

Many of the major rail yards around the country have been transformed into container transfer sites in the last five years. Large forklifts are used to load containers rapidly onto flat-top wagons. This approach minimises dangerous shunting processes, reduces the

number of locomotives and wagons being used, and provides more reliable and timely service to customers.

The point-to-point business model adopted by Toll Rail fits in well with the hubbing model that is gaining traction with the port companies. In 1999, Toll Rail and the Port of Tauranga developed Metroport. Metroport is located inland from Tauranga and allows the port to aggregate freight away from the main terminal in Tauranga. Toll Rail operates dedicated containerised freight services to meet shipping schedules and allows customers access to more frequent international shipping services that call at the Port of Tauranga.

3.3.5 Railway statistics

The figures presented in Tables 3.2 and 3.3 are taken from the Tranz Rail annual reports (Tranz Rail, various years).

Table 3.2 Annual rail freight (tonnes and tonne-kms).

Year	Tonnes (thousands)	Tonne-kms (millions)
1996	10 305	3261
1997	11 525	3505
1998	11 706	3547
1999	12 900	3671
2000	14 699	4078
2001	14 461	3942
2002	14 330	3766
2003	14 822	3853

Table 3.3 Rail revenue per freight type ($million).

Freight category	1996	1997	1998	1999	2000	2001	2002	2003
Agricultural and food products	149.9	152.4	163.5	155.0	157.7	165.1	163.8	–
Forestry products	70.8	71.6	67.5	73.2	78.8	71.5	61.3	–
Manufactured products	73.2	78.0	73.4	73.4	76.3	73.0	54.0	–
Coal	46.9	48.5	35.8	28.8	32.3	32.6	35.8	–
Fertiliser, minerals and aggregates	18.4	15.4	17.7	15.2	15.6	17.1	11.4	–
Other freight	41.5	39.0	64.2	74.7	85.3	104.2	108.3	–
Total revenue	**400.7**	**404.9**	**422.1**	**420.3**	**446.0**	**463.5**	**434.6**	**448.0**

3.3.6 Rail summary

Major restructuring of the rail industry over the last five years may significantly influence inter-regional freight movements throughout New Zealand. OnTrack is committed to improving the critical points in the rail network that limit weight capacities and impose speed restrictions on rail services. Toll Rail has completely restructured rail yard operations and train configurations to improve loading times and to meet the increasing demand for containerisation. Toll Rail is also forming partnerships with major port companies to provide a complete freight logistics service for customers exporting goods overseas. International increases in fuel costs may also make road transportation less competitive, especially over long distances.

3.4. Shipping

3.4.1 New Zealand's coastal shipping history

Prior to the 1960s, the population base throughout New Zealand was more evenly spread and many regional industries catered for local needs. Long-haul transportation of freight was dominated by numerous shipping companies operating small ships between the main centres and regional ports of New Zealand. Long-haul transportation by road was virtually non-existent and rail was disadvantaged by the barrier of Cook Strait.

The first Cook Strait inter-island ferry was introduced by New Zealand Railways (NZR) in 1962. The ferry was immediately successful, exceeding the forecasted demand predicted by NZR. The number of small ships operating on the coastal shipping routes began to reduce steadily after the ferry service was introduced because of the direct rail link running the full length of the country.

Road transport was restricted to short-haul routes by legislation up to the late 1970s to protect the state-owned NZR. NZR had a near monopoly on land-based long-haul traffic. These restrictions were removed in the late 1970s and early 1980s. This resulted in direct competition on long-haul land-based routes, and coastal ships now had to compete with both road and rail.

The financial viability of coastal shipping was further reduced in the mid-nineties, when the Maritime Transport Act (1994) opened the domestic coastal routes to foreign shipping. This also affected road and rail because a number of shippers found they could now move their goods around the country more cheaply on foreign ships than with land-based carriers.

3.4.2 Coastal shipping today

A major finding of the New Zealand shipping review, published in December 2000 (Ministry of Transport 2000), found that very few statistics were available relating to the commercial activities of the domestic shipping industry. No reliable information was available on the tonnages of cargo or the movement of containers around, or in and out of New Zealand.

The review recommended that Statistics New Zealand should collect and maintain a comprehensive range of shipping statistics including volumes of cargo moved into, out of and around New Zealand by foreign and domestic carriers. The review team was concerned that a lack of data would hinder planning and policy development for the industry. This was a concern, given the fundamental changes that were happening in freight logistics with the introduction of hubbing.

In 2003, Statistics New Zealand recommended that the Ministry of Transport (MOT) should be responsible for collecting and maintaining shipping statistics. In August 2004, the MOT approached port companies to supply data about shipping cargo for the 2003/2004 financial year.
The data supplied to the MOT were commercially sensitive to the port companies, so only combined total figures were published. A summary of the coastal cargo volumes is given in Table 3.4.

Table 3.4 Annual coastal cargo from all port companies in the 2003/2004 financial year (million tonnes).

Cargo	Containerised	Non-containerised	Total
Domestic cargo	3.79	3.85	7.65
Exports/imports in transit	0.89	0.09	0.98
Total coastal cargo	**4.68**	**3.95**	**8.63**

Note: data sourced from MOT 2005.

Other key statistics showed the following:

- New Zealand coastal shipping carried 85% of the total, with 15% (1.33 million tones) carried by overseas ships sailing between New Zealand ports.
- Containerised cargo plus road and rail freight carried across Cook Strait represents 54% (4.68 million tonnes) of the total domestic cargo.

In 2005, New Zealand's shipping industry was based almost entirely around coastal shipping services linking the main centres and a few regional ports.

The number of New Zealand-based coastal operators has not changed significantly from the early nineties. Only Pacifica Shipping operates a dedicated coastal and general cargo shipping service outside the Cook Strait inter-island route served by the Interisland Ferries and Strait Shipping.

Apart from the general cargo services, other significant domestic operations are the bulk shipping operations of the local oil industry and the cement industry. Two coastal tankers distribute refined products from Marsden Point throughout the country. The two major cement companies also operate in-house bulk cement carriers.

The only other locally owned coastal service of significant size is the Sea Tow tug and barge operation, which carries bulk cargoes such as sand and coal.

Table 3.5 New Zealand coastal shipping operators at November 2000 (from MOT 2000).

Company	Vessel	Gross registered tonnes	Vessel type
Coastal Tankers	*Taiko*	21,187	Oil tanker
	Kakariki	27,795	Oil tanker
Milburn	*Milburn Carrier II*	6,200	Bulk cement carrier
	Westport	3,091	Bulk cement carrier
Tranz Rail Interisland Line	*Arahura*	13,261	Rail and passenger ferry
	Aratere	12,596	Rail and passenger ferry
	Lynx	6,581	Fast ferry
Pacifica Shipping	*Spirit of Competition*	5,269	Roll on, roll off
	Spirit of Resolution	3,806	Container lift on, lift off
	Spirit of Vision	4,285	Roll on, roll off
	Spirit of Enterprise	4,529	Container lift on, lift off
Strait Shipping	*Suilven*	3,638	Roll on, roll off
	Straitsman	1,481	Roll on, roll off
Golden Bay Cement	*Golden Bay*	3,165	Bulk cement carrier
Leslie Shipping	*Jenka*	520	Livestock carrier
Sea Tow	Tugs (x2)	690	Bulk
	Barges (x4)	6,512	Bulk
Total		124,606	

3.4.3 International shipping trends

International cargo-carrying capacity increased significantly throughout the nineties. While growth in capacity has been relatively steady in bulk shipping, with a 20% increase in ten years, that of the container fleet has tripled. This has seen a significant increase in the average size of container vessels, whereas average bulk vessel size has shown little variation. Vessel speeds have increased as a result of more fuel-efficient engines.

A large increase in international trade during the 1990s has driven a rapid increase in global traffic of containerised cargoes (9% per annum) and bulk cargoes (2% per annum).

Intense competition in container markets has driven a development of new service patterns. The need to minimise costs by limiting port calls has led to an associated rise of global and local transhipment 'hub ports'. Although New Zealand still receives many direct shipping services to and from its major trading partners, international trans-shipment hub ports are being used increasingly; the most prominent in New Zealand's case being Singapore, followed by Hong Kong and others on the Pacific Rim. In October 2006, the shipping company Maersk announced reduced port calls in New Zealand with the Port of Tauranga losing a regular service. This demonstrates that decisions by international freight companies can lead to big shifts in regional freight routes and mergers of port companies.

Alliance building in the early 1990s has been giving way more recently to a wave of shipping company mergers and acquisitions. The merger of P&O and Nedlloyd and the recent acquisition of Sea-Land Service by Maersk Line are notable examples of this trend.

A summary of export freight by weight and value for all New Zealand ports is shown in Table 3.6.

Table 3.6 Exports from New Zealand ports in 2000/2001 (taken from Statistics New Zealand 2003a).

Region	Port	Weight (thousand tonnes)	Value (millions)
Northland	Whangarei	1051	$304
Auckland	Auckland and Onehunga	2020	$6,938
Waikato	Taharoa	876	$23
Bay of Plenty	Tauranga	6166	$7,270
Gisborne	Gisborne	524	$131
Hawkes Bay	Napier	1524	$2,110
Taranaki	New Plymouth	3365	$1,873
Manawatu/Wanganui	–	–	–
Wellington	Wellington	611	$1,422
Nelson	Nelson	1173	$851
Marlborough	Picton	102	$13
Canterbury	Lyttelton and Timaru	2697	$3,399
West Coast	–	–	–
Otago	Port Chalmers	935	$2,240
Southland	Bluff	645	$1,250

3.4.4 Hubbing

The historical practice of conventional (non-containerised) cargo ships travelling from port to port, loading and discharging is no longer economically viable. International and domestic freight is increasingly transported in containers because of the ease and speed of handling.

Hubbing refers to the practice of aggregating export and import cargoes at selected 'hubs' for dispatch to their destinations. This practice is emerging in New Zealand and will have a large effect on transport infrastructure.

The increasing size of foreign ships leads to difficulties with docking at smaller ports. The cost of sending large foreign ships 'hopping' around the coast to discharge or load relatively small volumes of cargo is no longer economically viable.

Hubbing will increase land-based freight volumes, particularly the volumes of export cargo which will be carried to 'hubbing' ports rather than to the local regional port. Hubbing generally reduces overall transport costs which in turn helps New Zealand exports remain competitive in international markets.

Eighty percent of New Zealand's imports are destined for the top half of the North Island. As a consequence, the majority of international ships make their first call at either Auckland or Tauranga.

New Zealand's principal exports are products derived from the primary sector such as dairy products, timber, meat and fruit. Consequently, export production is widely spread around the country. Many ports were traditionally developed to cater for the export requirements of producers in their immediate catchment area.

Maersk, which currently carries 20% of the worldwide container traffic, has recently announced a decision to use Auckland and Port Chalmers as its major port destinations and has scaled back visits to the Port of Tauranga. This will have a major effect on the hubbing of some export goods that will be diverted to Auckland rather than to the Bay of Plenty.

3.4.5 Shipping summary

The industry share of freight carried by domestic shipping has reduced dramatically over the last 20–30 years because of increasing competition from land-based freight operators. This has been mainly driven by deregulation of the freight industry, continuing cost efficiencies in land-based freight industries and international competition. Entering the New Zealand shipping market is cost-prohibitive because of the large capital outlay to acquire ships and the relatively small shipping market.

International ships are increasing in size, which limits the ability of ships to make numerous port calls throughout the country. This can have a significant influence on freight logistics and the location of freight hubs. If major shipping companies decide to reduce the number of port visits throughout the country, this can have a profound effect on the inter-regional movements of commercial vehicles as export goods are redirected to alternative port destinations.

4. IO analysis

4.1. Introduction

The objective of this analysis was to derive an OD matrix of truck trips for the fourteen transit regions using regional IO tables. This is the first time this approach has been used in New Zealand, as it is only recently that economists have divided national statistics in this regard into regional statistics. The research will therefore, in its own right, provide a valuable contribution to the understanding of freight movement in New Zealand.

The IO analysis was undertaken by Adolf Stroombergen, an economist with Infometrics. The analysis report is presented as a stand-alone paper in Appendix A, with the associated tables of figures presented in Appendix B.

4.2. Overview of the methodology

Regional IO tables provide gross output and exports in the form of dollar values for each region. The exports comprise all goods leaving the region including those destined for offshore but no information has been provided on their final destination. Similarly, the IO tables can be used to derive the value of imported goods into a region but no information is available on where they came from.

Table 4.1 shows a typical IO table for one particular region (Northland). The full IO dataset contains 114 industries, but for the purposes of this study, they were combined to reduce the number down to a more manageable 17 industries. The difference between gross outputs and exports represents the goods that are consumed within the region.

Table 4.1 IO data table for Northland.

Industry group	Exports*	Gross output
Horticulture	$129,098	$209,933
Pastoral agriculture	$237,288	$795,665
Forests	$216,526	$307,700
Fishing	$88,161	$113,415
Mining	$82,090	$100,863
Meat processing	$160,084	$216,623
Dairy processing	$431,238	$504,933
Other food, beverages and tobacco	$38,305	$91,088
Textiles	$17,403	$30,701
Wood products	$102,650	$177,232
Paper products	$27,681	$65,288
Petroleum	$539,139	$567,284
Chemicals	$41,778	$111,209
Non-metallic products	$52,041	$91,271
Basic and fabricated metals	$55,407	$98,534
Equipment and machinery	$117,849	$218,355
Services	$1,295,288	$4,259,076
Total	**$3,632,027**	**$7,959,171**

* Exports to other New Zealand regions and overseas.

Exported goods for each region are sent to 13 other regions throughout New Zealand and offshore to overseas markets. IO analysis is used to estimate the proportion of goods destined for each region in New Zealand and overseas. The analysis is repeated for each region to derive an overall OD matrix in dollar values.

Trade between each region is estimated using a gravity model approach. Trade is therefore proportioned between each region depending on economic masses and the inverse of the distance.

The economic masses include a comparison of the relative output of a particular industry in the region of origin versus the size of the industry in the destination region. For example, a region that is particularly strong in the horticultural industry will tend to generate more trade with a region with very little horticultural production rather than with another region with similar horticultural output.

Trade is also influenced by distance. A true gravitational force depends on the inverse proportion of the distance squared. Given that the cost of transport per unit length (e.g. dollars per km) decreases with increasing distance, only distance has been used in the equation rather than 'distance squared'. Using 'distance squared' would be too powerful and would effectively 'zero out' any trade between regions located at either end of the country.

Another major assumption of the model is that the overall proportion of offshore exports in a particular industry across the whole of New Zealand is the same in each individual region. For example, if 30% of New Zealand's horticulture is exported overseas, the assumption is that each region sends 30% of its horticulture overseas.

4.3. Converting from dollars to tonnes

The IO analysis returns the dollar values of goods transported to and from each region, including international exports. The dollar values are then converted to physical units (tonnes) to enable the final calculation of trips between regions.

Ideally, the weight and price information used to produce the Statistics New Zealand Producer's Price Index (PPI) would be ideal; however, this information is confidential and was not available. Therefore, information on weights and prices for 90 imported and exported commodities were used to compile an average price per tonne for the industries used in the IO analysis presented here and in Appendix A. This assumes that the export and/or import prices are reasonable representations of the gross output price for goods traded domestically.

Some adjustments were made to the average price per tonne to reduce the effect of small quantities of large value items that tend to skew the average price. Average import and export prices were used where significant differences in price were obvious. The price per tonne is summarised in Table 4.2.

Table 4.2 Average price per tonne of goods by industry.

Industry group	$/tonne
Horticulture	$1,400
Pastoral agriculture	$2,500
Forests	$270
Fishing	$5,630
Mining	$70
Meat processing	$5,020
Dairy processing	$3,820
Other food, beverages and tobacco	$1,850
Textiles	$7,460
Wood products	$2,740
Paper products	$1,090
Petroleum	$540
Chemicals	$1,590
Non-metallic products	$1,980
Basic and fabricated metals	$2,310
Equipment and machinery	$21,280

The service industry category is often a sizable proportion of regional output. However, it is assumed that only a negligible quantity of freight would be directly generated by the industries within this category. Therefore, this industry is not included in the conversion from dollars to weight.

4.4. Exports

Goods are produced for overseas exports throughout all regions in New Zealand. Ninety-nine percent of these goods (by weight) are transported to international markets via shipping. All regions in New Zealand are serviced by ports except Manawatu/Wanganui and the West Coast. Therefore, any goods produced in these two regions for overseas markets must require inter-regional transportation.

Producers of goods do not necessarily use the local port within their region. New Zealand port companies compete with one another to attract export goods by offering favourable shipping schedules and regular rail services. Most goods destined for overseas markets are containerised except for bulk commodities such as coal, logs and liquids. Given that rail dominates the transportation of bulk goods and large quantities of containers, inter-regional transportation of most overseas bound goods are likely to travel by rail over long distances to the port of preference.

Table 4.3 compares the weight of goods produced in each region for international export markets versus the weight of goods loaded onto ships bound overseas. Accurate records of export and import quantities through New Zealand ports are collected by New Zealand Customs.

The goods produced in each region shown in Table 4.3 are derived from the IO analysis. The total export weight recorded at New Zealand ports is in reasonable agreement with the IO analysis. Percentage comparisons of total weight produced in each region versus port export loadings show that the bigger ports like the Port of Tauranga tend to attract goods from outside their region.

Table 4.3 Regional international exports versus goods loaded at local ports.

Region	Port	Goods produced in regions[a]		Goods loaded at ports[b]		Difference[c]
		Tonnes	%	Tonnes	%	
Northland	Whangarei	1364	7%	1099	5%	-2%
Auckland	Auckland	2743	15%	2013	9%	-6%
Waikato	Taharoa	3406	18%	876	4%	-14%
Bay of Plenty	Tauranga	1330	7%	6411	29%	22%
Gisborne	Gisborne	477	3%	565	3%	0%
Hawkes Bay	Napier	1009	5%	1596	7%	2%
Taranaki	New Plymouth	546	3%	3445	15%	12%
Manawatu/ Wanganui	–	742	4%	0	0	-4%
Wellington	Wellington	833	4%	620	3%	-1%
Nelson	Nelson	622	3%	1193	5%	2%
Marlborough	Picton	526	3%	106	0%	-3%
Canterbury	Lyttelton Timaru	1411	8%	2924	13%	5%
West Coast		1633	9%	0	0	-9%
Otago	Port Chalmers	1295	7%	937	4%	-3%
Southland	Bluff	628	3%	645	3%	0%
Total		**18 566**	**100%**	**22 431**	**100%**	**–**

Notes to Table 4.3:

a From IO analysis for the year ended 31 March 2001.

b From New Zealand port statistics for the year ended 30 June 2001 (Statistics New Zealand 2003a).

c A negative value indicates goods are transported to ports outside the region.

The following assumptions about transportation of international export goods between regions are drawn from Table 4.3:

- **Northland:** Twenty-five percent of goods are transported to ports outside of Northland. The most likely destinations are Auckland or Tauranga. Most goods would be transported by rail to Tauranga, or by a mix of rail and road to Auckland.
- **Auckland:** Thirty-three percent of goods are transported to ports outside of Auckland. The most likely destination is Tauranga. Most goods would be transported by rail.
- **Waikato:** Eighty percent of goods are transported to ports outside of the Waikato. Most goods would be transported to the port of Tauranga, with a small proportion or goods going to Auckland. Waikato's port at Taharoa is a small specialist port catering for iron sand exports.

- **Bay of Plenty:** A negligible amount of export goods would be transported to ports outside of the Bay of Plenty, given that the Port of Tauranga is New Zealand's busiest port. The Port of Tauranga is likely to handle some goods from most regions in the North Island, with the exception of Gisborne and Napier, given the lack of direct rail access.
- **Gisborne:** Most of the goods produced within Gisborne are loaded at the port of Gisborne.
- **Hawkes Bay:** Most of the goods produced within the Hawkes Bay are loaded at the port in Napier. The port of Napier may also handle 25% of goods produced within the Manawatu/Wanganui region.
- **Taranaki:** Most of the goods produced within Taranaki would be loaded at the port in New Plymouth. Some goods may be transported by rail to the Port of Tauranga. The large quantity of goods loaded at New Plymouth (15% of all NZ exports by weight) would be dominated by bulk quantities of methanol and petroleum products. This has not been reflected in the quantities derived from IO analysis. The reason for this underestimation is the cost of methanol per tonne is significantly less than the average value that represents all chemicals used in the IO analysis. The result is an underestimation of the overall weight of goods produced in Taranaki.
- **Manawatu/Wanganui:** Goods produced for export markets are likely to be shared between the ports at Wellington, New Plymouth, Napier and Tauranga.
- **Wellington:** Most of the goods produced within the Wellington region would be loaded at the port in Wellington. A small proportion of goods are probably transported to the Port of Tauranga by rail.
- **Nelson:** Most of the goods produced in the Nelson region would be loaded at the port in Nelson. Transportation of goods to other ports outside the Nelson region would be limited by the lack of rail access.
- **Marlborough:** Most of the goods produced in Marlborough would be transported to Nelson by road, or by road/rail to Lyttelton. The port in Picton is not on the international shipping route and primarily caters for the domestic shipping industry operating on Cook Strait.
- **Canterbury:** The Canterbury region is served by two ports in Lyttelton and Timaru. The bulk of goods produced in Canterbury are transported to Lyttelton. Goods produced in South Canterbury may be transported to Timaru.
- **West Coast:** The bulk of goods produced on the West Coast are transported by rail to the port at Lyttelton.
- **Otago:** Most of the goods produced in Otago are transported to Port Chalmers. Some goods may be transported north to the ports at Timaru and Lyttelton.
- **Southland:** Most of the goods produced in Southland are loaded at the port in Bluff.

Based on the assumptions above, Table 4.4 estimates the percentage of export goods produced in each region that are loaded at regional ports. It is important to note that this

table is an estimate based on the regional assumptions above and a comparison of the road distances versus rail access.

Table 4.4 Percentage of regional international export goods loaded at regional ports.

Region of origin	Port loading region														
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Nelson	Marlborough	Canterbury	West Coast	Otago	Southland
Northland	75	10		15											
Auckland		67		33											
Waikato		10	20	70											
Bay of Plenty				100											
Gisborne					100										
Hawkes Bay						100									
Taranaki				15			85								
Mwtu / Wang				35		25	15	0	25						
Wellington				15					85						
Nelson										100					
Marlborough										45	5	50			
Canterbury												100			
West Coast												100	0		
Otago												10		90	
Southland															100

A large proportion of goods travelling to busy ports from outside the originating region are transported by rail. However, the proportions change from year to year given the changes in demand for different modes of transport and the logistic services offered by the transportation and port companies.

4.5. Converting from tonnes to trip numbers

The last step for deriving an OD matrix of commercial vehicle trips is to convert the total weight of goods to commercial vehicle trip numbers. The IO analysis was completed across 16 broad industries. Each industry has unique transportation requirements. The major downside of using IO analysis is that it does not distinguish between the mode of transportation (road, rail or shipping). The IO analysis output is the total weight of goods that need to get from A to B. The mode of transport depends on numerous factors and varies across industries depending on handling weights, quantities and trip distances.

Chapter 3 summarised the three major modes of transportation used in New Zealand and highlighted the lack of information on regional freight movements available in the public domain. It also highlighted that the data that are available are not that reliable, given how freight logistics in New Zealand change because of various domestic and international factors. This research highlighted that simple assumptions based on national statistics would be more practical for deciding the split of transportation modes.

Hence, the weight-based OD matrix for all modes of transport was proportioned with 75% being carried by road, 20% by rail and 5% by shipping.

The final step is to convert the total weight carried by road to actual trip numbers.

The average payload of a commercial vehicle was taken from data used in the Heavy Vehicle Limits Project (TNZ 2001) and is summarised in Table 4.5.

Table 4.5 Average payload of commercial vehicles by industry.

Industry group	Average load (Tonnes)
Horticulture	14.9
Pastoral agriculture	17.3
Forests	17.8
Fishing	14.6
Mining	16.8
Meat processing	16.9
Dairy processing	16.3
Other food, beverages and tobacco	16.1
Textiles	16.0
Wood products	16.0
Paper products	16.3
Petroleum	15.9
Chemicals	15.9
Non-metallic products	15.6
Basic and fabricated metals	16.1
Equipment and machinery	15.1

The final OD matrix using IO analysis is given in Table 4.6:

Table 4.6 OD matrix of inter-regional freight vehicles derived by IO analysis (using 2001 annual traffic numbers)

		Destination Region															
		Northland	**Auckland**	**Waikato**	**BoP**	**Gisborne**	**Hawke's Bay**	**Taranaki**	**Mwtu/Wang**	**Wellington**	**Nelson**	**Marlborough**	**Canterbury**	**West Coast**	**Otago**	**Southland**	**Total Vehicle Leaving Region**
Region of Origin	**Northland**	0	66669	11022	14198	495	2284	2377	2855	5188	696	429	3611	231	1088	595	**111737**
	Auckland	10034	0	44597	56973	1060	5166	5499	6235	11292	1342	845	6775	440	1978	1064	**153300**
	Waikato	3932	112550	0	123258	881	4792	5116	5400	9116	1002	643	4932	301	1390	736	**274048**
	BoP	1266	22862	11885	0	469	1857	1655	2132	3502	395	253	1960	127	561	300	**49226**
	Gisborne	415	5529	2069	1612	0	1585	535	1248	2046	228	145	1157	75	330	176	**17148**
	Hawke's Bay	849	11732	4966	2787	687	0	1522	4860	5887	510	339	2450	156	662	347	**37757**
	Taranaki	326	4589	1957	4680	87	560	0	1358	2076	191	127	899	59	246	126	**17281**
	Mwtu / Wang	559	7543	2932	13496	288	10989	6984	0	18215	517	369	2277	143	574	288	**65175**
	Wellington	756	10021	3671	7751	347	2297	2179	7141	0	1158	933	4615	287	1082	534	**42772**
	Nelson	408	4826	1636	935	155	806	816	1538	4685	0	1556	4863	439	1020	488	**24171**
	Marlborough	322	3894	1345	767	128	694	694	1415	4820	12673	0	16564	275	840	389	**44820**
	Canterbury	1049	11949	3980	2286	389	1888	1900	3335	9207	2370	1790	0	1442	6690	2508	**50784**
	West Coast	1280	14635	4817	2812	483	2330	2309	4021	10872	4142	2075	99877	0	5136	2274	**157062**
	Otago	916	10121	3264	1913	329	1506	1507	2465	6258	1469	943	25313	745	0	6982	**63729**
	Southland	339	3662	1175	689	119	529	529	847	2096	472	293	4924	229	4703	0	**20607**
	Total Vehicles Arriving	**22449**	**269384**	**99317**	**56009**	**5917**	**28857**	**28568**	**44851**	**86831**	**16517**	**10740**	**89907**	**4947**	**26300**	**16808**	**1129616**

5. SATURN modelling

5.1. Introduction

The aim of this section was to estimate an OD trip matrix for inter-regional heavy vehicle movements in New Zealand, using observed traffic link count information. The form of the estimated OD trip matrix is the same used in the IO analysis looking at the fifteen Transit regions. To estimate the OD[1] trip matrix from traffic counts, the computer software package SATURN[2] was used.

SATURN is a traffic network analysis program used by transport planners to model and test the impacts of roading projects on an area-wide network. SATURN also provides a suite of supplementary programs with useful applications for developing models. One of these supplementary models is SATME2, commonly known as ME2. ME2 adjusts the prior[3] OD trip matrix by using traffic count information, so the fit between modelled and observed flows match more closely, while being constrained to identify the least biased and most probable trip matrix.

Using ME2, it is possible to estimate an OD trip matrix for regional heavy vehicle movements from their traffic counts. Users should be aware of some limitations and points when using this method and these are discussed. The estimated OD trip matrix created from ME2 is compared with the IO analysis and the gravity modelling in Chapter 7.

5.2. The ME2 process

5.2.1 Introduction

Matrix Estimation from Maximum Entropy, abbreviated to ME2, attempts to seek the most probable trip matrix that is consistent with the information available; in this case, traffic link counts (de Ortúzar & Willumsen 1996). This section covers why ME2 was developed and how it can be used to estimate an OD trip matrix from traffic counts alone.

5.2.2 Assignment modelling

In order to understand what ME2 does and why it was developed, it is necessary to understand the basic structure of an assignment network model. The main use of any computer assignment model is to run in conjunction with a trip matrix, the 'demand', and a roading network, the 'supply', through the route choice algorithm. From this, the model estimates performance statistics such as link flows, cost, delays and queues of vehicles using the network. These statistics, in normal situations, are then used by transportation planners to report on the impacts/effectiveness of various network schemes over the existing base case. Figure 5.1 below shows the general process.

[1] The OD trip matrix can also be referred as a trip matrix or, even more simply, as a matrix.
[2] SATURN was developed by Dirk Van Vliet from the institute for transportation studies from the University of Leeds, UK.
[3] The prior OD trip matrix (or prior matrix) is the initial matrix which is then adjusted through the ME2 process.

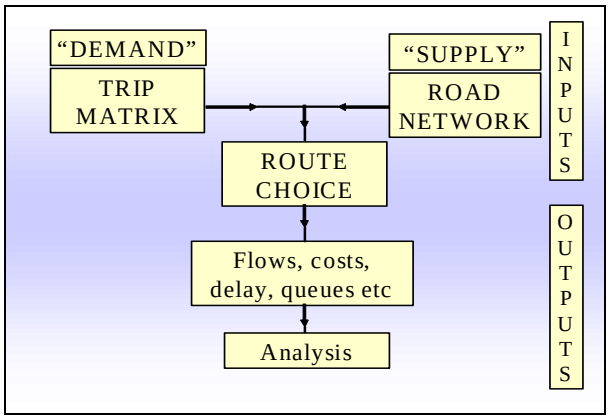

Figure 5.1 General structure of assignment models (based on Van Vliet 2004).

Figure 5.1 has three obvious sources of error in the assignment modelling process:

- errors from the OD trip matrix 'demand',
- errors from the network coding 'supply', and
- errors from the route selection algorithm.

The error in the OD trip matrix is the main cause of a model's varying from reality, as the trip matrix information is the hardest to obtain, and relies heavily on the quality of the data collected and how they are used.

Error from network coding has less of an impact, as good information from aerial photography normally exists, which gives the intersection layouts and the way they are connected in space.

The route selection algorithm will contain some minor errors. Its processes are held internally in the software and are based on the lowest cost from i-to-j, which normally is related to time and distance (although toll charges could be a component). The route selection algorithm can be altered by the modeller by changing the value for the time or distance used for route choice.

The extent of error (as indicated from the OD trip matrix) in any model is revealed when modelled flows are compared with actual counted flows. It should be noted that actual counted flows also contain error, which will result in count inconsistency across the network, although with careful use of count information, the errors and inconsistencies can be minimised. ME2 was developed to help address this error in a trip matrix by using traffic counts information to adjust the OD trip matrix.

5.2.3 Estimating a trip matrix from traffic counts

As indicated, what the ME2 method attempts to do is correct the error in the original prior OD trip matrix by working in the reverse direction of Figure 5.1. Extending this process further, ME2 can also be used to estimate an OD trip matrix from traffic count information alone. In this case, the prior trip matrix is replaced with a starter-base matrix. This is where all trips (OD cells) are equally likely (See Table 5.1).

To estimate a trip matrix from traffic counts, entropy should be maximised as shown below:

$$Maximise\ S(Tij) = -\Sigma\ (Tij\ log\ (Tij\ ) - Tij\ ) \qquad \text{Equation 1}$$

While subject to the constraint of:

$$\Sigma\ ij\ T_{ij}\ P_{ija} \quad = \quad V_{a\ obs} \qquad \text{Equation 2}$$

Where:

T_{ij} is the output matrix;
P_{ija} is the fraction of trips from *i* to *j* using link *a*; and
$V_{a\ obs}$ is the observed flow on counted link *a*.

ME2 performs this process to find the least biased matrix that satisfies the count information that has been.

5.3. Methodology of trip matrix estimation

5.3.1 Scope

The methodology discusses how SATURN and its supplementary program ME2 were used to estimate a regional OD trip matrix for heavy vehicles from traffic counts.

5.3.2 Network definition

The first step was to define the New Zealand network within SATURN. This was done by importing a scaled bitmap image of New Zealand that included the main highways marked on it. Using this as a template, it was possible to build the network over the top of it, using the SATURN network building tool 'Pmake'.

The network coding was all done in 'Buffer', which has a lot less detail, as this method of network coding removes intersection simulations. This is an appropriate method as the model deals with a very large network – the whole of New Zealand – and hence any intersection delays would be lost in the scale of the links of the network. Also, the network is intended to be only a means of using ME2 within SATURN to estimate the OD trip matrix.

The most important part of the network building was to make sure all relative links for inter-regional heavy traffic are catered for in the network. The basic network structure is based on the New Zealand network defined in the IO analysis and the state highways

available to follow that general route. Figure 5.2 shows the extent of the New Zealand network that was coded into SATURN.

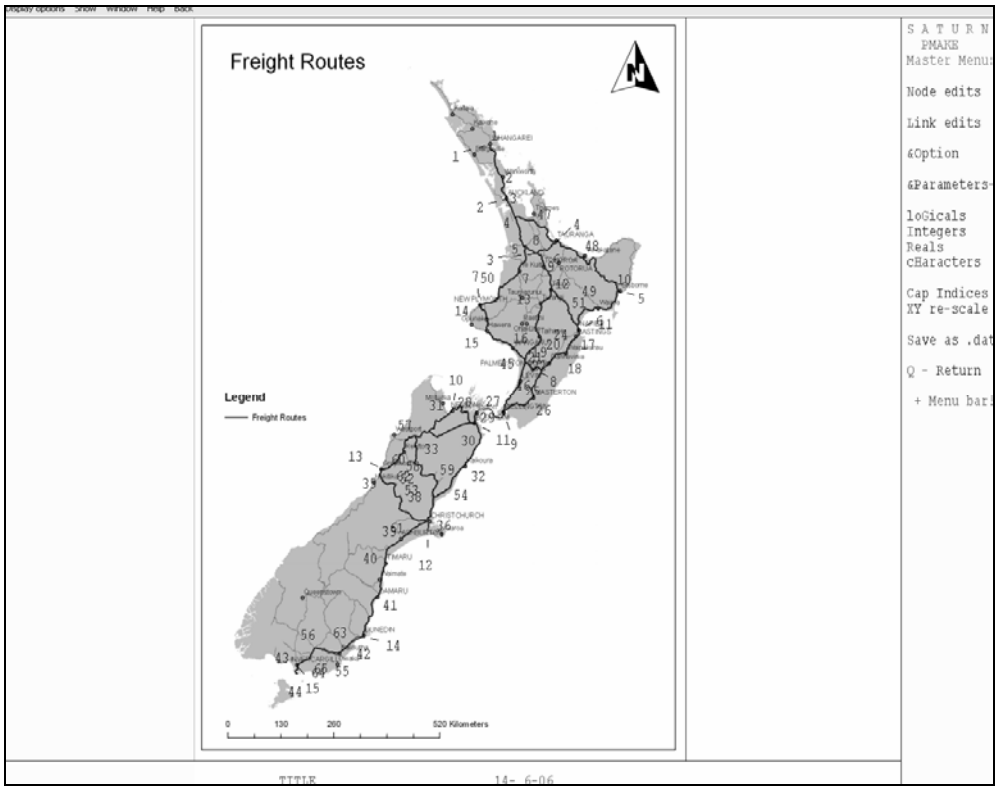

Figure 5.2 Screenshot of SATURN showing the New Zealand network used for the modelling.

The network data file created is unusual in that it models for a whole day. Normally, separate periods of the day are modelled to account for different traffic demands throughout the day. By considering the day as a whole, it assumes a flat, day-long traffic demand profile. This is unlikely, but is seen as an acceptable simplification because the network data file is used only to help estimate the day-long OD trip matrix.

5.3.3 Traffic count information

After defining the network in SATURN and testing/fixing the coding errors, the next stage covered the input traffic count information. For the ME2 process to run in SATURN, directional (i.e. node a to node b) traffic count information is coded directly into the network data file.

The traffic count information used in the ME2 trip matrix estimation was that obtained for the gravity modelling work. It is important to note that the traffic count information used must be for inter-regional traffic counts only. If any intra-regional traffic is included, a distorted estimated trip matrix will result. To try to avoid the inevitable contamination from local traffic of the required regional traffic counts, counts used were taken at (or

close to as possible to) regional boundaries. As suggested, this will not be perfect, but it is the best that can be done in the circumstances.

The counts obtained from the gravity modelling were in AADT (Annual Average Daily Traffic) form. This form does not give directional daily flows as required in ME2 modelling, just total daily link flows. To be able to use the AADT information, a spilt of 50/50 was assumed, to give directional flows. This was considered acceptable as the matrix estimation was for the entire day, which would remove any non-uniform directional splits from the counts.

Within SATURN and the ME2 process, it is possible to prioritise the count information it uses, so where inconsistencies exist, one count has greater weighting than another. This was not done, as the count informational came from the same source, and no distinction in terms of reliability was clear from one count to the next.

5.3.4 Running ME2 without a prior matrix

ME2 was primarily developed to help reduce error in an existing OD trip matrix, which it achieves by carrying out slight matrix adjustments and comparing modelled flows with observed traffic counts. The aim of this section of work differs in that it is to estimate an OD trip matrix purely from traffic count information. This means there is no starting trip matrix to work from. In cases like this, a starter-base trip matrix where all trip are equally likely is used. Table 5.1 shows the base trip matrix used in this analysis in the place of a prior matrix.

Table 5.1 Base-starter matrix used as prior trip matrix for ME2.

Origin	Destination															
	Northland	**Auckland**	**Waikato**	**Bay of Plenty**	**Gisborne**	**Hawkes Bay**	**Taranaki**	**Manawatu/ Wanganui**	**Wellington**	**Nelson**	**Marlborough**	**Canterbury**	**West Coast**	**Otago**	**Southland**	**Total**
Northland	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**14**
Auckland	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	**14**
Waikato	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	**14**
Bay of Plenty	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	**14**
Gisborne	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	**14**
Hawkes Bay	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	**14**
Taranaki	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	**14**
Manawatu/ Wanganui	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	**14**
Wellington	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	**14**
Nelson	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	**14**
Marlborough	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	**14**
Canterbury	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	**14**
West Coast	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	**14**
Otago	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	**14**
Southland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	**14**
Total	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**210**

Once we have all the elements necessary to carry out an ME2 process – i.e. a network data file with observed directional traffic counts coded in and a prior matrix (or in this case a starter-base matrix) – we can begin running ME2 in SATURN.

In order to run ME2 in SATURN, two programs are used in conjunction: SATPIJA and SATME2. SATPIJA analyses the output data from a SATURN run and produces PIJA data for each OD cell from this. PIJA data are the fraction of trips from regions i-to-j using link "a" in the network, and are derived from the observed count information and the modelled flows on that link. These PIJA factors, once calculated, are then fed into SATME2 along with the prior trip matrix. From this process, a new trip matrix is generated. This process is iterated a number of times.

The amount of proportional change allowed to an OD pair in the prior matrix in the ME2 process is controlled by XAMAX, an input into the ME2 process. When dealing with a prior trip matrix, it is normal to keep this low in order to control the amount of change and reduce distortion from possible poor count information. However, in the case of

developing a trip matrix from traffic count information alone, the XAMAX was allowed to increase until small or no change occurred in the generated OD trip matrix. XAMAX inputs of 100 and 500 were tested.

5.4. Results from SATURN ME2 modelling

By following this methodology, we obtained the following results. Table 5.2 shows the matrix estimated with a XAMAX of 100, while Table 5.3 shows the estimated trip matrix with a XMAX of 500.

Table 5.2 Estimated OD trip matrix with a XAMAX of 100.

Origin	Destination															
	Northland	**Auckland**	**Waikato**	**Bay of Plenty**	**Gisborne**	**Hawkes Bay**	**Taranaki**	**Manawatu/ Wanganui**	**Wellington**	**Nelson**	**Marlborough**	**Canterbury**	**West Coast**	**Otago**	**Southland**	**Total**
Northland	0	1	80	167	38	98	44	32	61	1	1	0	1	5	13	**542**
Auckland	1	0	100	208	47	122	55	40	77	1	1	0	1	6	17	**676**
Waikato	80	100	0	88	20	1	1	0	1	0	0	0	0	0	0	**291**
Bay of Plenty	168	208	88	0	0	91	49	30	57	1	1	0	1	5	12	**711**
Gisborne	38	47	20	0	0	25	11	56	56	1	1	0	1	5	12	**273**
Hawkes Bay	98	122	1	91	26	0	136	2	2	0	0	0	0	0	0	**478**
Taranaki	44	55	1	49	11	134	0	62	120	1	1	0	1	10	26	**515**
Manawatu/ Wanganui	31	38	0	29	56	2	60	0	2	0	0	0	0	0	0	**218**
Wellington	62	77	1	58	56	2	120	2	0	0	0	0	0	0	0	**378**
Nelson	1	1	0	1	1	0	1	0	0	0	1	0	95	8	22	**131**
Marlborough	1	1	0	1	1	0	1	0	0	1	0	0	1	8	22	**37**
Canterbury	0	0	0	0	0	0	0	0	0	0	0	0	0	59	152	**211**
West Coast	1	1	0	1	1	0	1	0	0	96	1	0	0	17	44	**163**
Otago	5	6	0	5	5	0	10	0	0	8	8	59	17	0	3	**126**
Southland	13	17	0	12	12	0	26	0	0	22	22	152	44	3	0	**323**
Total	**543**	**674**	**291**	**710**	**274**	**475**	**515**	**224**	**376**	**132**	**37**	**211**	**162**	**126**	**323**	**5073**

Table 5.3 Estimated OD trip matrix with a XAMAX of 500.

Origin	Destination															
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Nelson	Marlborough	Canterbury	West Coast	Otago	Southland	Total
Northland	0	1	142	143	32	84	45	26	58	0	0	0	0	3	8	**542**
Auckland	1	0	232	234	52	138	74	42	95	0	0	0	0	5	13	**886**
Waikato	142	233	0	106	24	1	0	0	0	0	0	0	0	0	0	**506**
Bay of Plenty	143	234	105	0	0	92	33	28	63	0	0	0	0	3	9	**710**
Gisborne	32	53	24	0	0	24	7	59	59	0	0	0	0	3	8	**269**
Hawkes Bay	84	139	1	93	26	0	138	2	2	0	0	0	0	0	0	**485**
Taranaki	45	74	0	33	7	135	0	59	132	1	1	0	0	7	18	**512**
Manawatu/ Wanganui	25	41	0	27	59	2	57	0	2	0	0	0	0	0	0	**213**
Wellington	58	96	0	64	59	2	132	2	0	0	0	0	0	0	0	**413**
Nelson	0	0	0	0	0	0	1	0	0	0	1	0	100	13	34	**149**
Marlborough	0	0	0	0	0	0	1	0	0	1	0	0	0	13	34	**49**
Canterbury	0	0	0	0	0	0	0	0	0	0	0	0	0	59	152	**211**
West Coast	0	0	0	0	0	0	0	0	0	100	0	0	0	17	44	**161**
Otago	3	5	0	3	3	0	7	0	0	13	13	59	17	0	3	**126**
Southland	8	13	0	9	8	0	18	0	0	34	34	152	44	3	0	**323**
Total	**541**	**889**	**504**	**712**	**270**	**478**	**513**	**218**	**411**	**149**	**49**	**211**	**161**	**126**	**323**	**5555**

The shaded areas in the trip matrices represent the North and South Islands' inter-regional heavy vehicle traffic movements, with the dark grey shaded area being the North Island's and the light grey being the South Island's. A point of interest is that the non-shaded areas have little traffic, supporting the constrained inter-island travel via Cook Strait. Some trends are a concern, with some close regions having little to no traffic between each other. Such examples include Northland to Auckland, Wellington to Manawatu/Wanganui, Nelson to Marlborough, and Southland to Otago.

This outcome in the estimated trip matrix certainly appears to be incorrect, as the expectation is that some inter-regional heavy traffic would exist between these regions. Interestingly, these low traffic trends occur at the ends of the islands where either a dead end exists or a major constraint like Cook Strait exists.

5.5. Discussion

The method of determining an OD trip matrix from traffic count information through the ME2 process has some limitations. These are detailed below:

- **Traffic count information accuracy:** The method relies totally on the accuracy of traffic count information put into the ME2 process. The method assumes the traffic count information used is perfect, although it is possible to prioritise count information. Traffic variations (e.g. seasonal or day-to-day) were not accounted for in the method. To improve the traffic count information, direction classification counts should be undertaken in locations where inter-regional traffic only is captured.
- **Inconsistent flows:** It is possible for inconsistent flows to be entered into the ME2 estimation process. In reality, these cannot exist at the same time. This results in an estimated trip matrix with obvious errors. Some credibility check in flows can be made, but with greater network complexity, these checks become virtually impossible. Within the ME2 process, suspect traffic count information can and should be given a lower priority. This will place emphasis upon the ME2 process meeting reliable counts.
- **Contaminated count information:** With larger models, such as this model of New Zealand, traffic count information should represent inter-regional traffic only, with an inter-regional OD trip matrix being created. However, if local traffic has contaminated the traffic count information, then it would certainly distort the inter-regional trip matrix being estimated. When collecting count information, ensure that the count site is located where commercial vehicles will be travelling between regions, and the local traffic is excluded.
- **Lack of a prior matrix:** Without a prior matrix, a base-starter matrix is used. This is a matrix where all trips are equally likely, as seen in Table 5.1. Without a prior matrix, the developed matrix has little to be compared with and the effects more popular zones are lost – distortion in the generated matrix could exist without ever being checked. With greater assurance in the IO analysis and the gravity modelling matrices, it may be possible to use one of these matrices as a prior matrix. These were not used in this analysis, as the IO analysis matrix did not account for empty vehicle trips (as it was based on goods transfer), while the gravity model matrix had significant difference from the matrices from the IO and ME2 (with a base-starter matrix) analysis.
- **Validation of the SATURN model:** The model will require validation at some stage and this may be problematic, as the traffic count information used to create the trip matrix cannot be used for validating purposes.

The ME2 model was useful in identifying trends: the model showed the inter-island trend well, with little traffic travelling between islands. It was useful for comparing with other developed estimated trip matrices. With more information, and being aware of limitations, ME2 is a useful tool for estimating an OD trip matrix with relative ease.

5.6. Summary and recommendations

5.6.1 Recommendations

The traffic count information put into the ME2 process is crucial to the estimation of a credible OD trip matrix. The traffic count information used for this analysis was a summary of count information used in the gravity modelling. In order to improve the OD trip matrix estimation with ME2, the traffic count information would require the following improvements:

- Undertake new day long directional classification counts to improve the reliability in the traffic counts.
- When collecting count information, ensure the count site is located where only inter-regional traffic will exist, with the local traffic excluded.
- With the data collection, any count information that is suspect should be given a lower priority in the ME2 process. This will place emphasis upon the ME2 process meeting reliable counts.
- Adjust count information for seasonal variations, so count information is consistent. This will require consistency checks.

Other improvements would be to have a prior matrix. It maybe possible to use one of the matrices created in IO analysis and the gravity modelling as a prior matrix. In order to do this, greater confidence in these matrices will need to be developed.

5.6.2 Summary

In summary, an OD trip matrix was created that showed some expected trends, such as low heavy vehicle movements between the islands. With more work and consideration of some of the points discussed above, such as the importance of good reliable traffic count data, a better trip matrix would be generated.

The effort involved in using ME2 to estimate an OD trip matrix is much less compared to other methods. On the most part, it is uncertain just how good it is – the estimation of heavy traffic origins and destinations by three different methods has given three different answers, with no 'absolute' for comparison. It is only further refinement of each of the three methods, perhaps associated with limited travel surveys that would answer this.

Within the SATURN package, matrix estimation using ME2 with no prior matrix is not recommended in future; it could be in error in many ways without the user being aware.

6. Gravity modelling

6.1. Overview

The aim of this section of the research was to construct a gravity model that could be used to estimate and forecast the level of inter-regional heavy vehicle traffic in New Zealand.

This research forms the second stage of a two-stage investigation. This stage considers commercial vehicle traffic between regions, and the first stage of the research examined commercial vehicle traffic within regions.

This component of the second stage of research involved the construction of a basic economic gravity model. The gravity model uses economic variables such as GDP and population, and transportation variables such as the distance between regions or the time taken to travel between regions then calibrates the results against actual commercial vehicle traffic counts. The intention is to determine if the relative economic sizes of regions can be used to predict the commercial vehicle traffic between regions.

In this research, a series of gravity models were generated. They were statistically significant, giving confidence that approximately 69–76% of the variation in traffic counts can be explained by GDP and distance (time taken) variables. This is within the range determined in empirical gravity modelling.

Calibrating the results with actual traffic counts revealed that other factors cause variation in the model for some regions. As the model is limited to examining two variables (GDP and distance), other factors such as a strong rail or shipping presence or transportation/distribution hubs may create distorted results that are not picked up in the model. The results from the calibration also highlighted that the relative size of the regional economies can cause the model to give unsatisfactory results when comparing economies that are significantly different in size.

The results indicate that it may be worthwhile to construct a set of regional models, rather than taking a national model approach. The benefits of taking a regional, rather than national, approach would mean that it would be possible to include regional specific dummy[4] variables to capture the effects of things like the presence of a rail link or other major transportation alternatives, or proximity to ports, airports or other transportation/distribution hubs.

[4] A dummy variable is a numerical variable used in regression analysis to represent subgroups of the sample in the study. A simple example would be to use a 0/1 dummy variable, where a region is given a value of 0 if no airports are on that regional link or a 1 if an airport is present on the link.

The results and recommendations contained in this report are summarised below:

- Statistically significant results indicate that gravity modelling can be a useful tool in estimating traffic counts.
- Calibration against actual count information indicates that the model needs to be refined further.
- Further research should investigate the construction of regional models with the inclusion of dummy variables for alternative transportation modes (rail, shipping) and regional generators/attractors (airports, ports, distribution hubs).

6.2. Methodology

The gravity model is often used in the statistical analysis of bilateral flows between geographic locations. The first mathematical representation of the gravity model was Isaac Newton's 'Law of Universal Gravitation' (Newton 1687). This theory stated that the attractive force between two objects *i* and *j* is given by:

$F_{ij} = G\, M_i M_j / D^2_{ij}$ Equation 3

where:

F_{ij} = Attractive force between objects *i* and *j*.

M_i , M_j = Mass of objects *i* and *j*.

D_{ij} = Distance between *i* and *j*.

G = Gravitational constant[5].

Newton's theory was later expanded on by Jan Tinbergen in 1962 when the first gravity model of trade was created. This led to the creation of two economic formulations of gravity modelling that covered spatial and social interactions. The spatial interaction model is a trip distribution or OD model, and examines the relationship between two geographic locations and the travel costs (measured in distance, money, time, etc) between them. The spatial interaction models are widely used as an element of transportation modelling. The social interaction model is an economic model of trade. The gravity model is used to predict trade flows and is based on the economic masses, usually GDP and population, and the distance between two geographic locations. For the purposes of this research, we have opted to examine the economic model of trade, using traffic counts as a proxy for the flow of goods between regions.

The gravity model for social interactions is expressed in a similar manner to the original law of universal gravitation and is given by:

$F_{ij} = C\, M_i^{\alpha} M_j^{\beta} / D_{ij}^{\theta}$ Equation 4

[5] G, the gravitational constant (also known as Newton's Constant), is difficult to measure. The most widely accepted figure today is $(6.67482 \pm 0.0010) \times 10^{-11} m^3\, kg^{-1}\, s^{-2}$ (National Institute of Standards and Technology 2007).

where:

F_{ij} = Measure of flow between origin *i* and destination *j.*

M_i , M_j= Economic sizes of locations *i* and *j.*

D_{ij} = Distance between the two locations *i* and *j.*

C = Constant

Using the gravity model as an economic model of trade implies that the flow variable (i.e. traffic counts) decreases caused by trade barriers such as distance, $D_{ij.}$

The multiplicative nature of the gravity model means that we need to take natural logs[6] to transform the gravity model into a linear model representing the relationship between the flow variable and the economic masses and distance. This is illustrated as:

$$\ln F_{ij} = C + \alpha \ln M_i + \beta \ln M_j - \theta \ln D_{ij} + \varepsilon_{ij} \quad \text{Equation 5}$$

The inclusion of the error term, ε_{ij}, means that our equation can be solved using ordinary least squares (OLS) regression. Note that taking the natural log of a constant variable generates a constant variable so ln C is left here as C for simplicity.

Empirical results of OLS gravity modelling of trade typically generate an R^2 value between 0.65 and 0.95. The R^2 value is a measure of the explanatory power of the model and measures the percentage of variation in the dependent (flow) variable that can be explained by the variation in the independent (economic masses and distance) variables. The R^2 varies from 0.00 to 1.00, thus empirical results imply that 65%-95% of the variation in the dependent variable is explained by the independent variables.

After the model is estimated using OLS and the regression parameters are obtained, the model must be exponentiated to transform the equation back into its original multiplicative form. This is represented as:

$$F_{ij} = \exp(C)\, M_i^{\alpha} M_j^{\beta} D_{ij}^{\theta} \quad \text{Equation 6}$$

By transforming Equation 5 back into its original form (Equation 6), we are able to use the parameter results estimated in the OLS regression to estimate the traffic counts between regions and to develop a forecasting model for traffic counts.

[6] A natural logarithm is a logarithm to the base *e.*

6.3. Model construction

For the purpose of the model used in this research, both GDP and population were tested, separately and jointly, as independent variables. Annualised traffic counts of heavy vehicles were used as the dependent variable. The models are similar to Equation 5 and are expressed using the following equations:

$$\ln TC_{ij} = C + \alpha \ln GDP_i + \beta \ln GDP_j - \theta \ln TT_{ij} + \varepsilon_{ij} \quad \text{Equation 7}$$

$$\ln TC_{ij} = C + \chi \ln POP_i + \delta \ln POP_j - \theta \ln TT_{ij} + \varepsilon_I \quad \text{Equation 8}$$

$$ln\ TC_{ij} = C + \alpha ln\ GDP_i + \beta ln\ GDP_j + \chi ln\ POP_i + \delta ln\ POP_j - \theta\ ln\ TT_{ij} + \varepsilon_{ij} \quad \text{Equation 9}$$

where:

TC_{ij} = Annualised traffic count on the link *ij.*

GDP_i , GDP_j = GDPs of regions *i* and *j* respectively.

POP_i , POP_j = Populations of regions *i* and *j* respectively.

TT_i= Time taken to travel the distance between regions *i* and *j.*

Traffic counts were generated from TNZ's State Highway traffic volumes (TNZ 2007). The data we have used are from telemetry sites where Transit reports on the percentage of heavy motor vehicle movements. The full traffic count information is contained in Appendix C.

Tables C1 to C14 in Appendix C contain the AADTs for traffic counts across telemetry sites[7] that record the movements of heavy vehicles. The annual average daily total represents the total number of vehicles counted in a year divided by 365 days. This provides us with an average traffic count on any given day.

Tables C15 to C28 in Appendix C reports on the percentage of heavy motor vehicle movements based on the AADT count information. From this information, we can derive the AADT for heavy vehicles only (Total AADT x percentage of heavy motor vehicles), the results for which are reported in Tables C29 to C42 in Appendix C. These figures were then converted into annualised estimates by multiplying the AADT for heavy motor vehicles and the AADT for all vehicles by 300 days. The multiplier of 300 days was determined on the basis that heavy vehicles operate approximately 6 days a week and includes an adjustment for public holidays. The results of the annualised estimates can be found in Tables C43 to C70 in Appendix C.

Figures 6.1 and 6.2 are maps of the state highway network and the telemetry sites for both the North and South Islands. The telemetry sites are marked with the name of the telemetry site and a star (★).

[7] Telemetry sites refer to the continuous traffic monitoring sites where data are extracted by telecommunications.

For each inter-regional link, a path was traced between the origin and destination regions, and the telemetry sites located on the link were noted. An inter-regional link may pass over multiple telemetry sites. Where more than one telemetry site is present on the link, the maximum, minimum and average traffic counts have been recorded and modelled. Judgement was applied to regions where it is possible to travel on more than one state highway to reach the same destination, and the most likely route has been chosen. Tables 6.1 and 6.2 refer to the telemetry sites that are present on the inter-regional links.

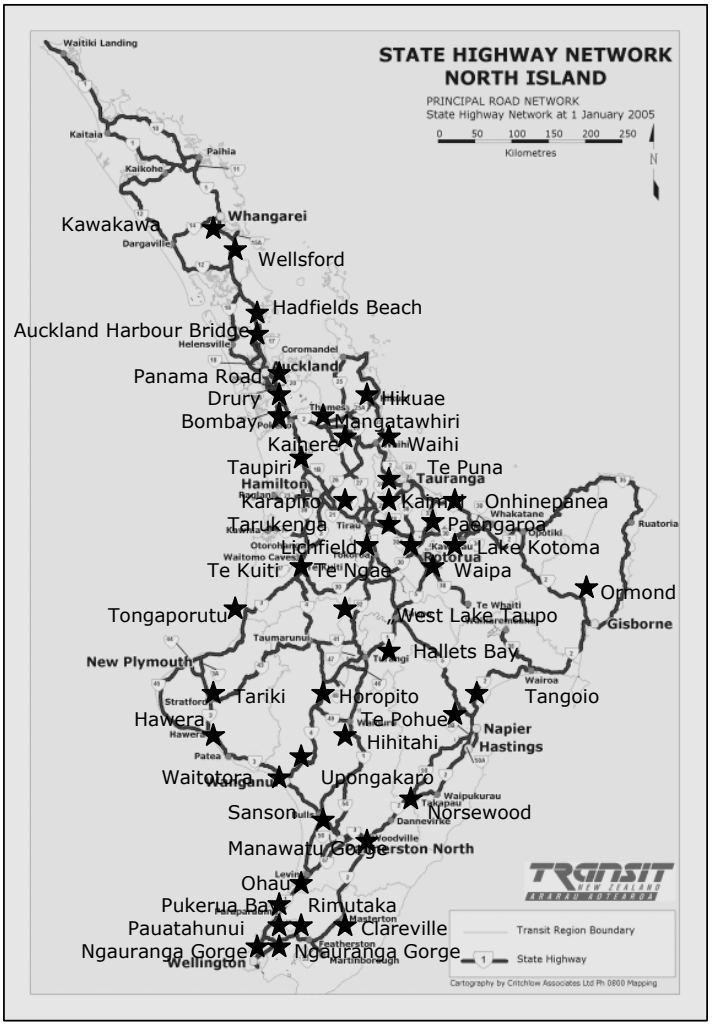

Figure 6.1 Telemetry sites along the state highway network in the North Island.

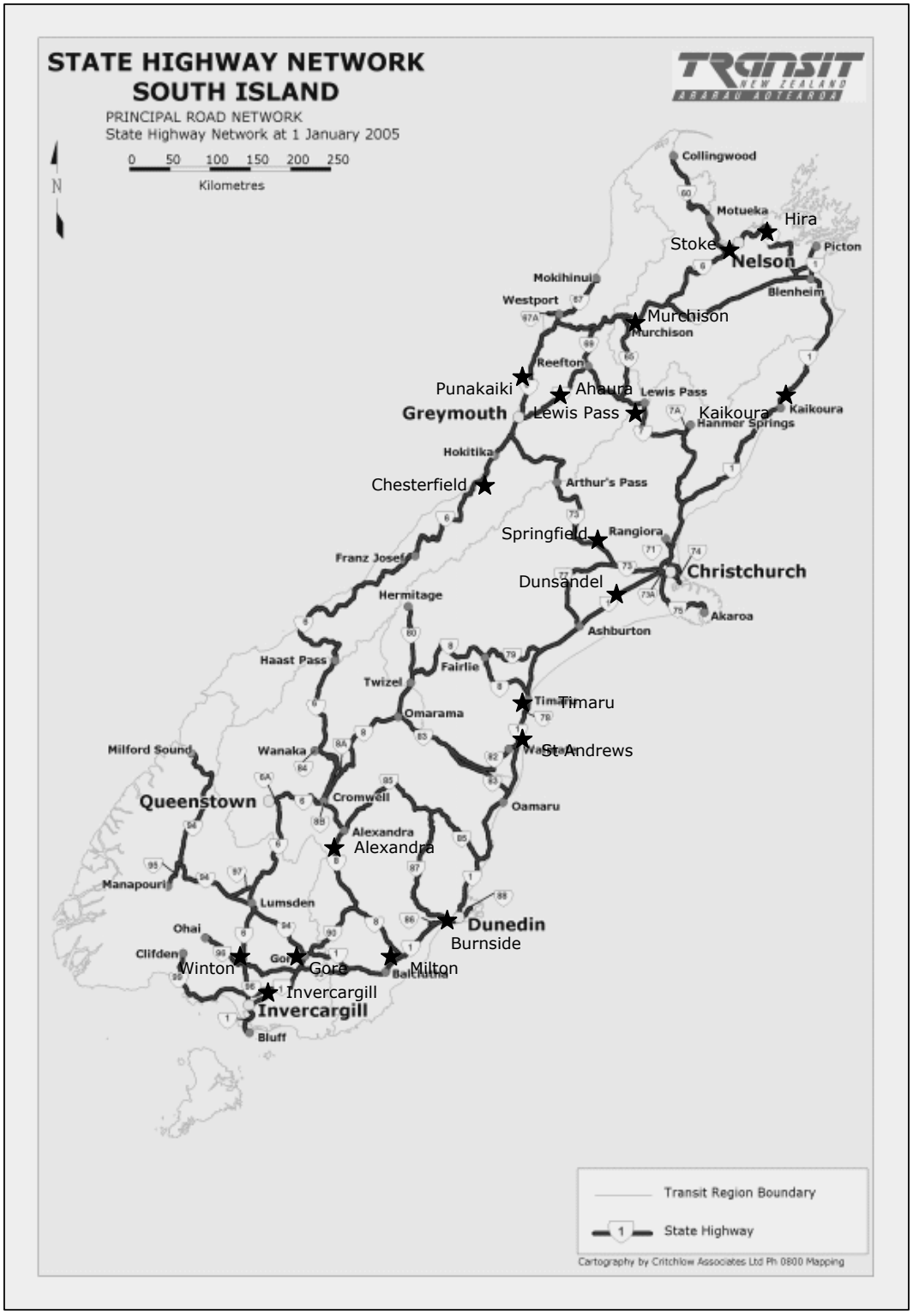

Figure 6.2 Telemetry sites along the state highway network in the South Island.

Table 6.1 Telemetry sites on inter-regional links (North Island destinations).

Origin	Destination	State highway	Telemetry site
Northland	Auckland	SH1	Kawakawa
		SH1	Hadfields Beach
Auckland	Waikato	SH1	Panama Road
		SH1	Drury
		SH1	Bombay
		SH1	Taupiri
Waikato	Bay of Plenty	SH1	Karapiro
		SH29	Kaimai
Waikato	Hawkes Bay	SH1	Karapiro
		SH5	Tarukenga
		SH5	Waipa
		SH5	Te Pohue
Waikato	Manawatu/Wanganui	SH1	Karapiro
		SH1	Lichfield
		SH1	Hallets Bay
		SH1	Hihitahi
Waikato	Taranaki	SH3	Te Kuiti
		SH3	Tongaporutu
Bay of Plenty	Gisborne	SH2	Onhinepanea
		SH2	Ormond
Bay of Plenty	Manawatu/Wanganui	SH33	Paengaroa
		SH30	Te Ngae
		SH5	Waipa
		SH1	Hallets Bay
		SH1	Hihitahi
Gisborne	Hawkes Bay	SH2	Tangoio
Hawkes Bay	Manawatu/Wanganui	SH50	Napier South
		SH2	Norsewood
		SH3	Manawatu Gorge
Taranaki	Manawatu/Wanganui	SH3	Tariki
		SH3	Waitotara
Manawatu/Wanganui	Wellington	SH1	Ohau
		SH1	Pukerua Bay
		SH1	Ngauranga Gorge

Table 6.2 Telemetry sites on inter-regional links (South Island destinations).

Origin	Destination	State highway	Telemetry site
Wellington	Marlborough	Cook Strait	-
Marlborough	Tasman/Nelson	SH6	Hira
Marlborough	Canterbury	SH1	Kaikoura
Marlborough	West Coast	SH6	Murchison
		SH6	Punakaiki
Tasman/Nelson	Canterbury	SH1	Kaikoura
Tasman/Nelson	West Coast	SH6	Murchison
		SH6	Punakaiki
Canterbury	West Coast	SH73	Springfield
Canterbury	Otago	SH1	Dunsandel
		SH1	Timaru
		SH1	St Andrews
Otago	Southland	SH1	Burnside
		SH1	Milton
		SH1	Gore
		SH1	Invercargill

Data on heavy vehicles crossing the Cook Strait were obtained from the Commercial Freight Manager at Interislander. Inter-island heavy vehicle counts were provided for 1997 and 2005. Values for the interim years were interpolated between these two values. We were advised that Interislander holds approximately 64% of the market share, with the remainder held by Strait Shipping. Adjustments were made to the vehicle counts to ensure that traffic count data from both the Interislander and Strait Shipping were taken into account.

The data for GDP by region were generated using the GDP by industry figures (actual chain-volume series expressed in 1995/96 prices) produced by Statistics New Zealand (Statistics New Zealand 2007). As regional GDP data were not available from Statistics NZ at the time of this research, our regional GDP estimates have been calculated using the number of geographic units split by region and industry provided by Statistics NZ. Using these data, the percentages of geographic units per region for each industry were calculated and these percentages were used to allocate national GDP data on a regional basis. The regional GDP estimates were then compared to published estimates[8] by the New Zealand Institute of Economic Research and were deemed to be reasonably robust. On 18th December 2006, Statistics NZ released its *Research Report of Regional Gross Domestic Product* (Statistics New Zealand 2006). The objectives of this project were to determine the feasibility of producing regional GDP data by industry. The estimates they have calculated are considered to be of acceptable quality at the regional level but have

[8] The figures are from a members-only page on the New Zealand Institute of Economic Research website, www.nzier.org.nz.

not yet been analysed in detail at industry level. A more detailed report, including sources and methods, is being released in 2007. The GDP by region data used in this analysis are contained in Appendix D.

The estimated resident population counts were obtained from Statistics NZ Census data and can be found in Appendix E. Appendix F contains the traffic counts that were used in the modelling based on the links detailed in Tables 6.1 and 6.2.

The models were run using maximum, minimum and average traffic count volumes. They were also run using distance in kilometres between regions *i* and *j,* and time taken to travel (in hours) between regions *i* and *j*. The distance variable effectively represents the cost of transport between regions *i* and *j* and is measured by the road distances and/or travel times between the main cities or towns.[9] When tested, travel time was a better proxy than distance, and included allowances for rest stops and road conditions. The travel times used were sourced from the New Zealand Automobile Association (NZAA) website (NZAA 2007) and are used to generate the tables in Appendix B3.4. The models were also run with the unemployment rate and labour force participation rates as independent variables. These were not found to add to the explanatory power of the model because they are correlated with the population variable.

Each of the models expressed in Equations 7–9 were run using maximum, minimum and average traffic count volumes (i.e. nine models were run for each year). This exercise was done using both distance in kilometres and travel times as a proxy for distance. As mentioned, the models using travel time as a proxy for distance yielded the best results. The model that was found to generate the best results was the model in Equation 7, which uses GDP and travel times to generate traffic counts. The models using minimum and average travel times generated statistically significant results, which are summarised in Tables 6.3 and 6.4. The complete regression results are located in Tables H1 and H2 in Appendix H.

[9] This uses the NZAA distances and travel times plus five hours (including wait time) for ferry crossings across Cook Strait.

Table 6.3 GDP minimum traffic counts: summarised regression output.

Year	Minimum			
	Constant	Ln $(GDP)_i$	Ln $(GDP)_j$	$Travel\ time_{ij}$
1997	-2.32 (-0.91)	0.39 (3.45) ***	0.55 (4.83) ****	-0.53 (-2.02) **
1998	-1.66 (-0.71)	0.38 (3.62) ****	0.52 (4.93) ****	-0.50 (-2.05) **
1999	-2.14 (-0.89)	0.39 (3.61) ****	0.53 (4.99) ****	-0.46 (-1.83) **
2000	0.01 (0.00)	0.32 (3.37) ****	0.48 (5.16) ****	-0.45 (-2.09) ***
2001	-0.76 (-0.36)	0.32 (3.36) ****	0.52 (5.54) ****	-0.46 (-2.06) **
2002	-1.33 (-0.58)	0.34 (3.27) ****	0.53 (5.32) ****	-0.32 (-1.37) *
2003	-0.30 (-0.13)	0.38 (3.69) ****	0.45 (4.61) ****	-0.62 (-2.67) ***
2004	-2.07 (-1.01)	0.42 (4.55) ****	0.50 (5.71) ****	-0.43 (-2.08) **

Notes to Tables 6.3 and 6.4

- The figures in brackets are the t-statistics (estimate divided by its standard error).
- **** indicates significance at the 1% level,
- *** indicates significance at the 5% level,
- ** indicates significance at the 10% level
- * indicates significance at the 20% level.

Table 6.4 GDP average traffic counts: summarised regression output.

Year	Minimum			
	Constant	Ln $(GDP)_i$	Ln $(GDP)_j$	$Travel\ time_{ij}$
1997	-2.21 (-0.73)	0.46 (3.36) ****	0.50 (3.67) ****	-0.54 (-1.73) **
1998	-2.11 (-0.75)	0.46 (3.60) ****	0.49 (3.87) ****	-0.53 (-1.81) **
1999	-1.96 (-0.70)	0.45 (3.59) ****	0.49 (3.91) ****	-0.51 (-1.73) **
2000	-1.02 (-0.36)	0.42 (3.31) ****	0.46 (3.65) ****	-0.45 (-1.54) *
2001	-1.40 (-0.58)	0.40 (3.68) ****	0.50 (4.69) ****	-0.43 (-1.72) *
2002	-1.40 (-0.58)	0.42 (3.83) ****	0.49 (4.66) ****	-0.42 (-1.71) *
2003	-0.74 (-0.26)	0.45 (3.47) ****	0.43 (3.52) ****	-0.61 (-2.09) ***
2004	-2.42 (-0.98)	0.50 (4.48) ****	0.47 (4.44) ****	-0.46 (-1.85) **

As can be seen by the significance indicators, the GDP Minimum Traffic Count model yields slightly more significant results than the GDP Average Traffic Count model. The results from Table 6.3 are exponentiated to transform the equation back into its original multiplicative form, yielding the results in Table 6.5.

Table 6.5 Final regression results for the GDP minimum traffic count model.

Year	Final regression results
1997	$TC_{ij} = \frac{0.098172\ GDP_i^{0.39} GDP_j^{0.55}}{TT_{ij}^{0.53}}$
1998	$TC_{ij} = \frac{0.190991\ GDP_i^{0.38} GDP_j^{0.52}}{TT_{ij}^{0.50}}$
1999	$TC_{ij} = \frac{0.117837\ GDP_i^{0.39} GDP_j^{0.53}}{TT_{ij}^{0.46}}$
2000	$TC_{ij} = \frac{1.005301\ GDP_i^{0.32} GDP_j^{0.48}}{TT_{ij}^{0.45}}$
2001	$TC_{ij} = \frac{0.467186\ GDP_i^{0.32} GDP_j^{0.52}}{TT_{ij}^{0.46}}$
2002	$TC_{ij} = \frac{0.265529\ GDP_i^{0.34} GDP_j^{0.53}}{TT_{ij}^{0.32}}$
2003	$TC_{ij} = \frac{0.743086\ GDP_i^{0.38} GDP_j^{0.45}}{TT_{ij}^{0.62}}$
2004	$TC_{ij} = \frac{0.126181\ GDP_i^{0.42} GDP_j^{0.50}}{TT_{ij}^{0.43}}$

Use of the final regression results for each year enables these models to be calibrated against actual traffic counts by inserting the GDPs for pairs of regions and the time taken to travel between these regions back into the model. This comparison enables a direct comparison of the actual traffic count against the estimated traffic count generated by the model. As the data comprised of actual traffic counts on selected links, only these links were able to be calibrated. The calibration results are recorded in Table 6.6. The results have been split into three categories:

- ±0–25% variance from the actual traffic counts (pale grey)
- ±26–50% variance from the actual traffic counts (dark grey)
- ±51%–100% variance from the actual traffic counts (black).

The final column in the table lists whether the region has passed (i.e. within ±0–25% variance from the actual traffic counts) or failed (±≥51 variance from the actual traffic counts). Regional links that had variances of ±26–50% have been recorded as inconclusive.

For two out of the three regional links that failed (Northland–Auckland and Canterbury–West Coast) the most likely reason for the results not calibrating is the relative sizes of these economies. The model generated traffic counts were 139% higher on the Northland–Auckland link and 98% higher on the Canterbury–West Coast link. However,

the GDP generated by the Auckland economy is 9–10 times the size of GDP generated in Northland and similarly, the GDP generated by Canterbury is 13–15 times that generated by the West Coast. Because the model only takes the relative GDPs between regions and the time taken to travel between them into account, it is highly likely that outside factors such as alternative transportation methods (primarily rail and shipping) or the presence of storage or distribution hubs may result in disproportionate variances between regions. It is unclear what is causing the variance on the Tasman/Nelson–West Coast link.

Table 6.6 Model calibration results.

Regional links	Variance	Variance category	Calibration test
Northland–Auckland	139%	±51% +	FAIL
Auckland–Waikato	-16%	±0–25%	PASS
Waikato–Bay of Plenty	14%	±0–25%	PASS
Waikato–Hawkes Bay	-4%	±0–25%	PASS
Waikato–Manawatu/Wanganui	-26%	±26–50%	INCONCLUSIVE
Waikato–Taranaki	20%	±0–25%	PASS
Bay of Plenty–Gisborne	-28%	±26–50%	INCONCLUSIVE
Bay of Plenty–Manawatu/Wanganui	-33%	±26–50%	INCONCLUSIVE
Gisborne–Hawkes Bay	-28%	±26–50%	INCONCLUSIVE
Hawkes Bay–Manawatu/Wanganui	-17%	±0–25%	PASS
Taranaki–Manawatu/Wanganui	-35%	±26–50%	INCONCLUSIVE
Manawatu/Wanganui–Wellington	-8%	±0–25%	PASS
Wellington–Marlborough	47%	±26–50%	INCONCLUSIVE
Marlborough–Canterbury	21%	±0–25%	PASS
Marlborough–West Coast	24%	±0–25%	PASS
Marlborough–Tasman/Nelson	-33%	±26–50%	INCONCLUSIVE
Tasman/Nelson–Canterbury	32%	±26–50%	INCONCLUSIVE
Tasman/Nelson–West Coast	58%	±51% +	FAIL
Canterbury–West Coast	98%	±51% +	FAIL
Canterbury–Otago	-38%	±26–50%	INCONCLUSIVE
Otago–Southland	-11%	±0–25%	PASS

Of the 21 regional links that were calibrated:

- 9 links could be calibrated within 25% of the actual traffic counts (42.9%);
- 9 links were within ±26–50% of the actual traffic counts (42.9%); and
- 3 links were more than 50% higher than the actual traffic counts (14.2%).

6.4. Forecasting

One advantage the gravity model has over other transportation models is the ability to generate models to forecast future traffic counts. For this exercise, forecasts have been generated on a short-term basis. With only eight years of data, it is unrealistic to expect to be able to generate forecasts of any great length. The forecasting models predicting traffic counts from 2005–2010 are shown in Table 6.7:

Table 6.7 Forecast regression results for traffic counts 2005–2010.

Year	Forecast regression model
2005	$\frac{TC_{ij} = 0.42\ GDP_i^{0.49} GDP_j^{0.52}}{TT_{ij}^{0.43}}$
2006	$\frac{TC_{ij} = 0.76\ GDP_i^{0.58} GDP_j^{0.43}}{TT_{ij}^{0.43}}$
2007	$\frac{TC_{ij} = 0.51\ GDP_i^{0.68} GDP_j^{0.48}}{TT_{ij}^{0.43}}$
2008	$\frac{TC_{ij} = 0.57\ GDP_i^{0.81} GDP_j^{0.50}}{TT_{ij}^{0.43}}$
2009	$\frac{TC_{ij} = 0.20\ GDP_i^{0.95} GDP_j^{0.39}}{TT_{ij}^{0.43}}$
2010	$\frac{TC_{ij} = 0.81\ GDP_i^{1.11} GDP_j^{0.45}}{TT_{ij}^{0.43}}$

By using the forecast regression models and assuming that the time taken to travel between regions remains constant over time, it is possible to create traffic count forecasts on particular links by incorporating regional GDP forecasts. Unfortunately, regional GDP information was not readily available at the time of this research. Regional GDP forecasts are available for purchase and Statistics NZ released a report in December 2006 discussing the feasibility of producing regional GDP data by industry (Statistics New Zealand 2006). The more detailed report on this study is due in 2007.

6.5. Summary and recommendations

Empirically, the social interaction augmentation of the gravity model has been used with success, with 65–95% confidence that the economic variables are predicting transportation flows. It also highlights that approximately 5–35% of transportation flows are generated by variables outside of the model.

In this research, we were able to generate a set of gravity models that were statistically significant. We can be confident that approximately 69–76% of the variation in traffic counts can be explained by our GDP and distance (time taken) variables. This is within the range determined in empirical gravity modelling work.

However, when the results were calibrated for individual inter-regional links, it became clear that other factors cause variation in the model. As the model is limited to examining

the two variables of GDP and distance, other factors such as a strong rail or shipping presence, or transportation/distribution hubs may be creating distorted results that are not picked up in the model. The results from the calibration also highlighted that the relative sizes of the regional economies can cause the model to give unsatisfactory results when comparing economies that are significantly different in size.

The gravity model constructed in this research was a national model. The results indicate that it may be worthwhile to construct a set of regional models. The benefits of a taking a regional, rather than national, approach would mean that it would be possible to include dummy variables to capture the effects of the presence of a rail link or other major transport alternatives, or proximity to ports, airports or other transportation/distribution hubs.

Gravity modelling can be a useful tool in the estimation of traffic counts. However, the calibration against actual count information has shown us that more work needs to be done to refine this model. Variables other than GDP and distance affect the model for some regions and this variation would be better picked up in a regional, rather than a national model. Current research taking place regarding the production of regional data should be closely followed, as this information will likely provide the base for any further research into a more comprehensive regional model.

7. Model comparisons

7.1. Overview

Three separate methodologies have been used to derive inter-regional counts of commercial vehicle freight movements in New Zealand.

The variability of the results illustrates that a single overall approach is probably not the correct strategy for developing a national inter-regional freight model. A combination of, say, gravity modelling and IO analysis is more likely to yield a representative model of inter-regional commercial vehicle flows.

Each method in its own right has positive and negative attributes.

IO analysis tries to rationalise the final destination of goods produced in each region for a broad range of industries based on relative comparisons of production capacity in all other regions to reach an equilibrium state. IO analysis uses a gravity model approach, so additional regional factors could be added to alter the equilibrium state.

Predicting future regional production (which is necessary to predict future commercial vehicle numbers) can be easily estimated using a base year of production and indexing using regional GDP data. The IO analysis will produce an OD matrix by total weight of goods for each industry. However, the IO analysis will not distinguish the mode of transportation used between regions or which port will attract goods destined for international export markets.

IO analysis indicates that around 50% of goods by weight are destined for international markets, so consideration of the likely port destinations for international exports by each industry is an important input to the model. Port specialisation, regional rail networks and limited international shipping calls at New Zealand ports will influence the amount of export goods carried by commercial vehicles and the regions they pass through to reach a particular port.

Both SATURN and gravity modelling attempt to rationalise the final destination of vehicles based on heavy vehicle traffic counts at regional boundaries. The gravity model rationalises the traffic at boundaries by considering the attractive attributes of potential destinations such as GDP or populations, but tempers the attraction with increasing distance.

SATURN modelling undergoes a similar process with traffic counts by using an algorithm that considers the main routes on the national highway network and attempts to send vehicles to a destination with the path of least resistance by minimising congestion.

Future estimates of traffic numbers using predictions of regional economic statistics can be used to predict future inter-regional freight movements. The traffic counts used to determine the gravity model variables do not distinguish between different types of goods, or whether the vehicles are fully laden or empty.

From an economics perspective, freight transport demand is a derived demand, which means its existence is derived from the need to move goods between different geographical locations caused by consumption by national and international consumers. Vehicles flows are a result of logistic decisions made by carriers to best meet this demand. Therefore, a freight model needs to take into account goods consumed by the regional communities and international consumers, as this directly influences a major proportion of commercial vehicle trips.

The two main inputs to a national freight model are commodity flows and/or vehicle flows. The three methodologies presented in this report generally use one of these categories as the main input to the model. Data on commodity flows generally focus on the type and quantity of goods moved, whereas vehicle flows focus on the mode of transport and trip numbers.

7.2. Graphs and discussion

7.2.1 General remarks

The following graphs represent the percentage of goods travelling to each region using each of the three models. Throughout most of the regions, the IO and the gravity modelling appear to generate the closest results in terms of the percentages of goods transferred from particular regions.

7.2.2 Northland

For goods transported to Northland, both the IO and the gravity model generate results indicating that the largest percentage of transported goods originate in Auckland. The IO model suggests that 45% of the goods arriving in Northland are from Auckland compared to 31% in the gravity model. For all other regions, the differences between the IO model and the gravity model are within ±5%. The SATURN model gives quite different results, indicating that 26% of the goods travelling into Northland originate from the Waikato and 26% from the Bay of Plenty, with none of the goods travelling into Northland arriving from Auckland. The SATURN model also indicates that only 2% of the goods arriving in Northland arrive from the South Island (1% each from Otago and Southland) compared to 19% and 20% respectively for the IO and gravity models.

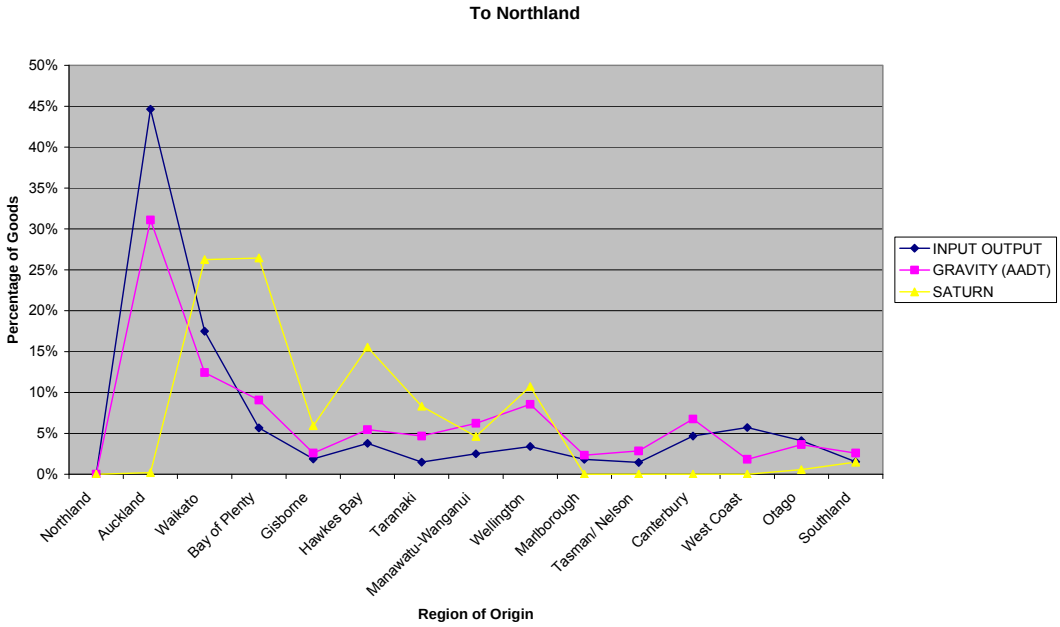

Figure 7.1 Origin of goods travelling to Northland, as predicted by all three models.

7.2.3 Auckland

For goods transported to Auckland, both the IO and the gravity model generate results indicating that the largest percentage of transported goods originates in the Waikato. The IO model suggests that 50% of the goods arriving in Auckland are from the Waikato; the gravity model suggests a figure of 20%. The gravity model also indicates that 11% of the goods transported to Auckland originate from Northland compared to 0% for the IO model. For all other regions, the differences between the IO model and the gravity model are within ±6%. The SATURN model gives slightly different results, indicating that 26% of the goods travelling into Auckland originate from the Waikato and 26% from the Bay of Plenty. The SATURN model also indicates that only 2% of the goods arriving in Auckland arrive from the South Island (1% each from Otago and Southland) compared to 22% for both the IO and gravity models.

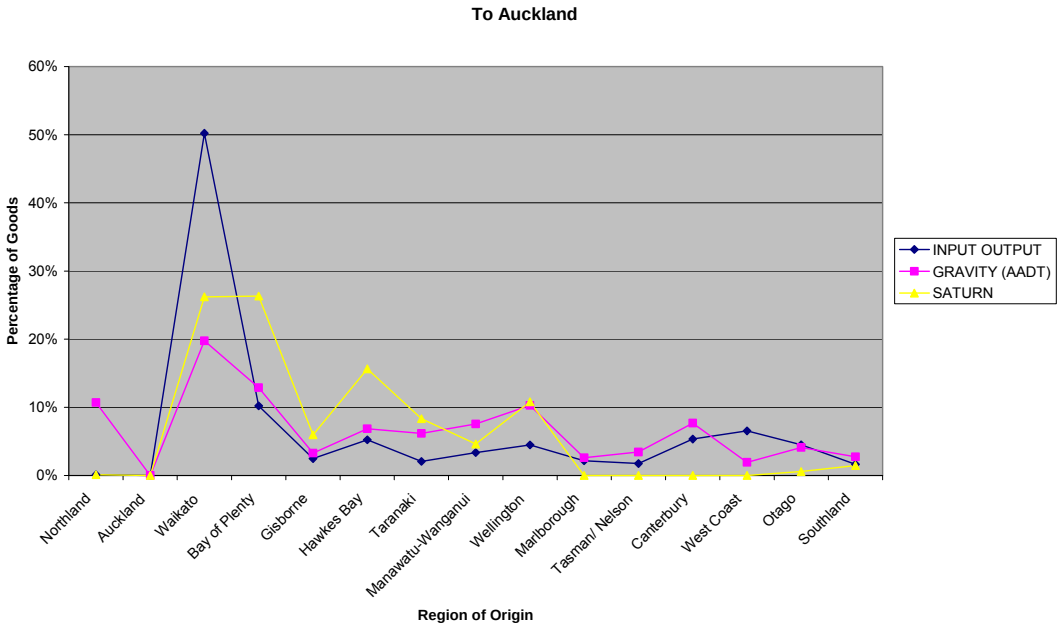

Figure 7.2 Origin of goods travelling to Auckland, as predicted by all three models.

7.2.4 Waikato

For goods transported to Waikato, both the IO and the gravity model generate results indicating that the largest percentage of goods arrives from Auckland. According to the IO model, 50% of the goods arriving in the Waikato are from Auckland, compared to 30% indicated by the gravity model. The IO model also indicates that 14% of the goods transported to the Waikato originate from the Bay of Plenty compared to 13% for the gravity model. For all other regions, the differences between the IO model and the gravity model are within ±6%. The SATURN model generates reasonably similar results, indicating that 46% of the goods travelling to the Waikato originate from Auckland and 28% and 21% respectively from Northland and the Bay of Plenty. The SATURN model also indicates that none of the goods arriving in the Waikato arrives from the South Island compared to 19% and 18% respectively for the gravity and IO models.

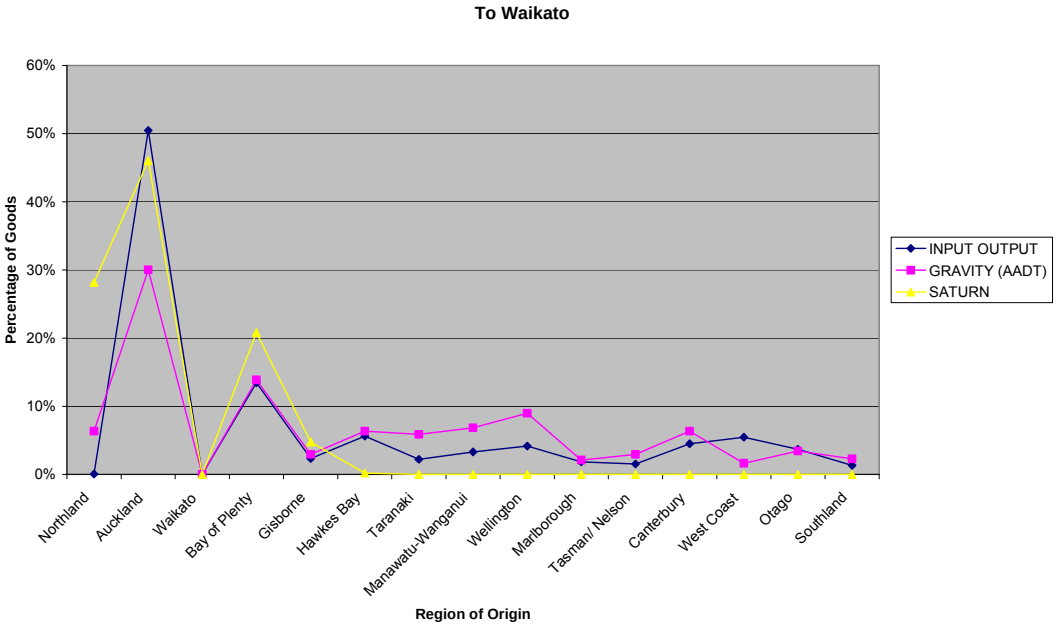

Figure 7.3 Origin of goods travelling to Waikato, as predicted by all three models.

7.2.5 Bay of Plenty

The IO indicates that the largest percentage of goods transported to the Bay of Plenty originates in Waikato. The IO model suggests that 56% of the goods arriving in the Bay of Plenty are from the Waikato compared to 18% in the gravity model. The gravity model indicates that Auckland is the biggest generator of flows of heavy vehicles into the Bay of Plenty with 25% of transported goods arriving from Auckland compared to 26% of goods with the IO analysis. For all other regions, the differences between the IO model and the gravity model are within ±6%. The SATURN model also indicates that Auckland generates most of the transported goods into the Bay of Plenty (33%), followed by Northland (20%), Waikato (15%) and Gisborne (13%). The SATURN model indicates that 2% of the goods arriving in the Bay of Plenty arrive from the South Island compared to 19% and 4% respectively for the gravity and IO models.

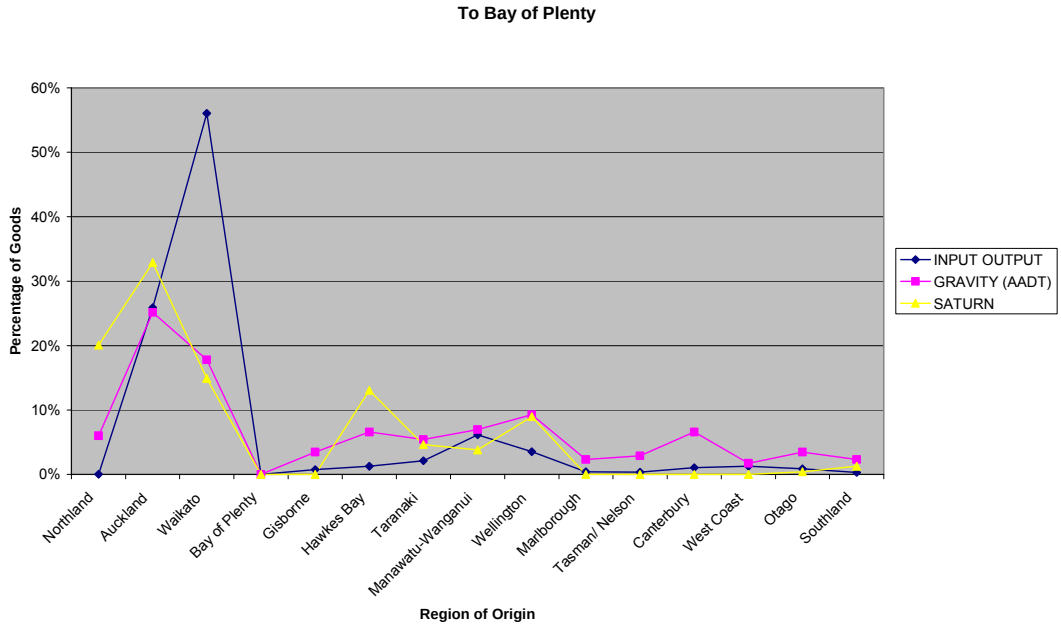

Figure 7.4 Origin of goods travelling to Bay of Plenty, as predicted by all three models.

7.2.6 Gisborne

Both the IO and the gravity model indicate that for goods transported to Gisborne, the largest percentage originates from Auckland (19%). The IO model also suggests that a further 16% of goods arriving in Gisborne are from the Waikato, followed by 13% from Hawkes Bay. This compares to 11% in the gravity model for both Waikato and Wellington and 10% from the Bay of Plenty. For all other regions, the IO model and the gravity model differ within the range of ±7%. The SATURN model gives quite different results, indicating that most goods into Gisborne originated in Manawatu/Wanganui (22%) and Wellington (also 22%). This was a followed by 19% of goods from Auckland, 12% from Northland and 10% from Hawkes Bay. The SATURN model indicates that 4% of the goods arriving into Gisborne arrive from the South Island compared to 22% and 30% respectively for the gravity and IO models.

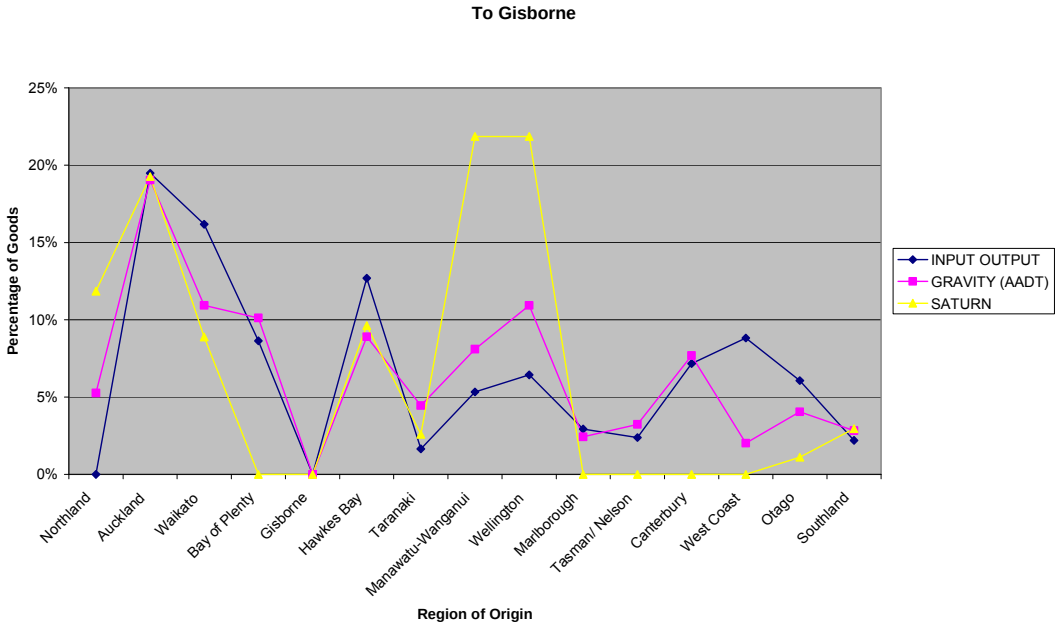

Figure 7.5 Origin of goods travelling to Gisborne, as predicted by all three models.

7.2.7 Hawkes Bay

The IO model suggests that the greatest amount of goods transported into Hawkes Bay originates in Manawatu/Wanganui (31%). The gravity model, however, predicts that Auckland is the greatest source of goods (19%). The IO model also suggests that Auckland and Waikato are the next most significant source of goods into Hawkes Bay (15% and 14% respectively). The gravity model gives Waikato as the second most likely origin (12%), along with Manawatu/Wanganui (12%) and followed by Wellington (11%). The SATURN model gives very different results, suggesting that the majority of goods into Hawkes Bay originate from Auckland (29%) and Taranaki (28%), followed by the Bay of Plenty (19%) and Northland (18%). The SATURN model makes the startling suggestion that little or no goods come into Hawkes Bay from anywhere south of Taranaki.

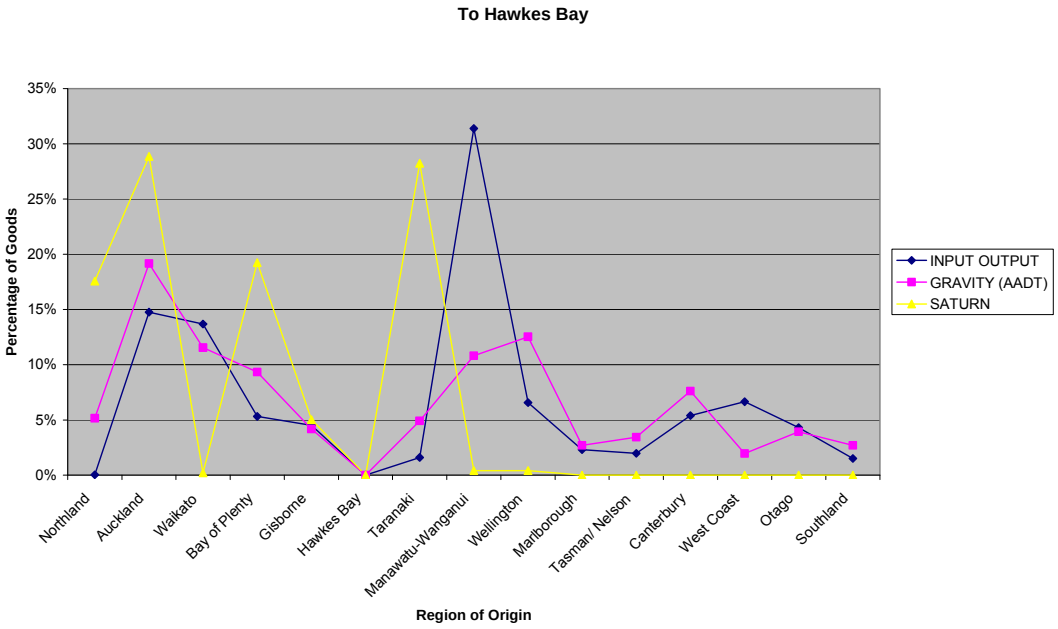

Figure 7.6 Origin of goods travelling to Hawkes Bay, as predicted by all three models.

7.2.8 Taranaki

For goods transported to Taranaki, the IO and the gravity model generate slightly different results. The IO model suggests that 22% of goods are transported originated in Manawatu/Wanganui, followed by 18% for Auckland and 16% for the Waikato. This compares to gravity modelling results, which indicate that 21% of the goods originated in Auckland, followed by 13% from the Waikato, 12% from Wellington and 10% from Manawatu/Wanganui. For all other regions, the differences between the IO model and the gravity model are within ±5%. SATURN gives quite different results, indicating that 27% of the goods transported originated in Hawkes Bay, followed closely by 26% from Wellington and a further 14% from Auckland. The SATURN model indicates that 5% of the goods arriving into Taranaki arrive from the South Island compared to 22% and 25% respectively for the gravity and IO models.

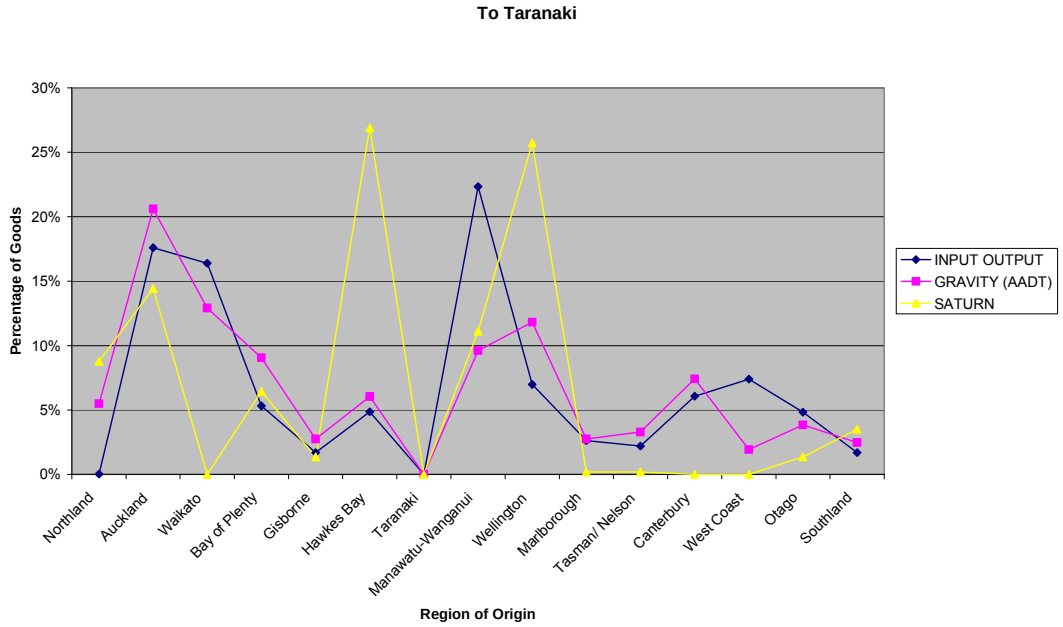

Figure 7.7 Origin of goods travelling to Taranaki, as predicted by all three models.

7.2.9 Manawatu/Wanganui

Both the IO model and the gravity model suggest that for goods transported to the Manawatu/Wanganui region, the largest percentage originates from Wellington (17% for the IO model and 18% for the gravity model). The IO model also suggests that a further 15% of goods arriving in the Manawatu/Wanganui area are from Auckland, followed by 13% from the Waikato, 12% from Hawkes Bay and 10% from the West Coast. This compares to 17% from Auckland in the gravity model and 10% from the Waikato. For all other regions, the differences between the IO model and the gravity model are within ±5%. SATURN gives quite different results, indicating that 27% of the goods transported originate from Hawkes Bay and another 27% from Taranaki. This was a followed by 19% of goods from Auckland and 12% from Northland. The SATURN model indicates that 0% of the goods arriving into the Manawatu/Wanganui region arrives from the South Island compared to 24% and 22% respectively for the gravity and IO models.

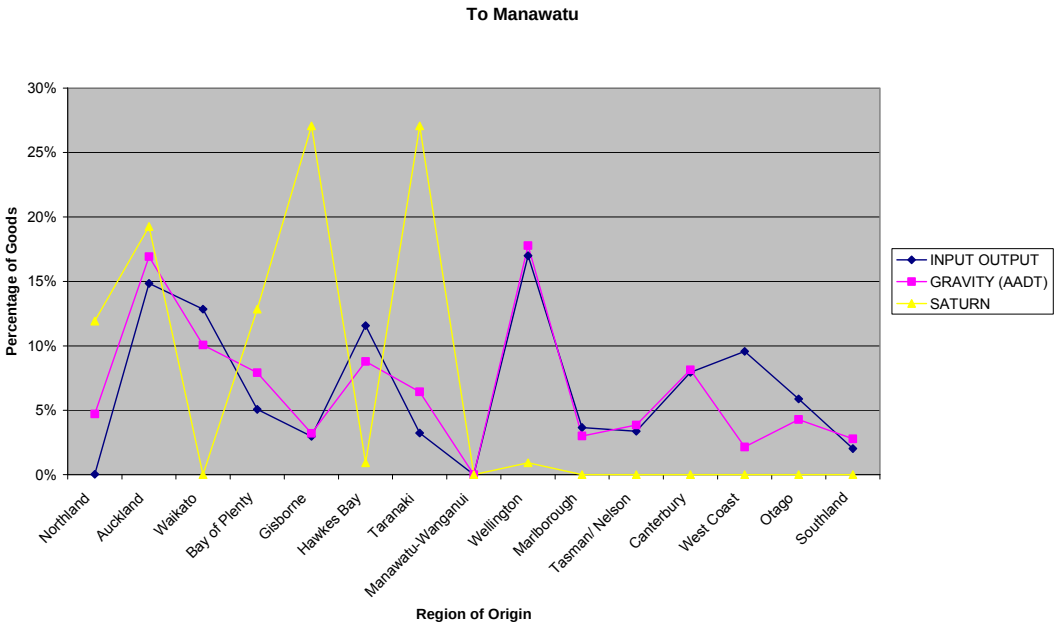

Figure 7.8 Origin of goods travelling to Manawatu/Wanganui, as predicted by all three models.

7.2.10 Wellington

For goods transported to Wellington, the IO and the gravity model generate similar results. The IO model indicates that 20% of the goods arriving in Wellington originated from Manawatu/Wanganui, followed by 13% from Auckland, 12% from the West Coast and 10% each from Waikato and Canterbury. For the gravity model, the largest percentage of goods originates from Auckland (17%) followed by Manawatu/Wanganui (13%) and 10% each from Waikato and from Canterbury. For all other regions, the differences between the IO model and the gravity model are within ±5%. SATURN gives quite different results, indicating that 32% of inbound goods originate in Taranaki. This is followed by 23% of goods from Auckland, 15% from the Bay of Plenty and 14% each from Northland and Gisborne. The SATURN model indicates that none of the goods arriving into Wellington come from the South Island compared to 30% and 42% respectively for the gravity and IO models.

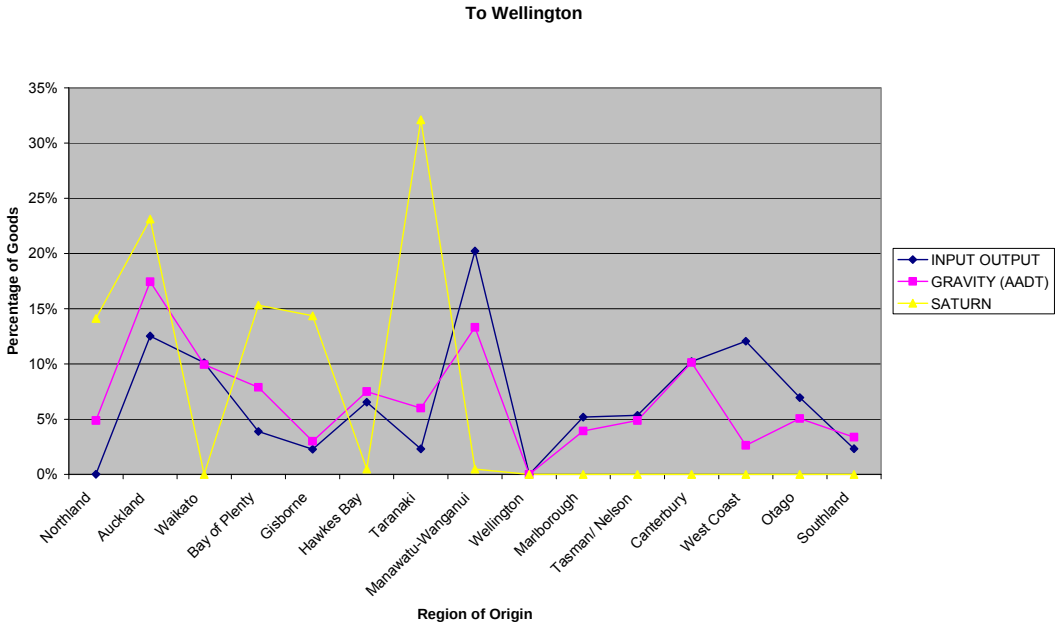

Figure 7.9 Origin of goods travelling to Wellington, as predicted by all three models.

7.2.11 Marlborough

Regarding goods bound for Marlborough, the IO and the gravity model generate quite different results. The IO model indicates that the largest percentage of transported goods originates in Tasman/Nelson (48%) followed by the West Coast (16%). The gravity model results show 14% of the goods each originating from Canterbury and from Auckland, followed by 13% of goods Wellington. For all other regions, the differences between the IO model and the gravity model are within ±5%. The SATURN model indicated that 67% of the goods transported originate in Tasman/Nelson, followed by 23% from Southland. The SATURN model indicates that 99% of the goods arriving into Marlborough are from within the South Island, compared to 37% and 80% respectively for the gravity and IO models.

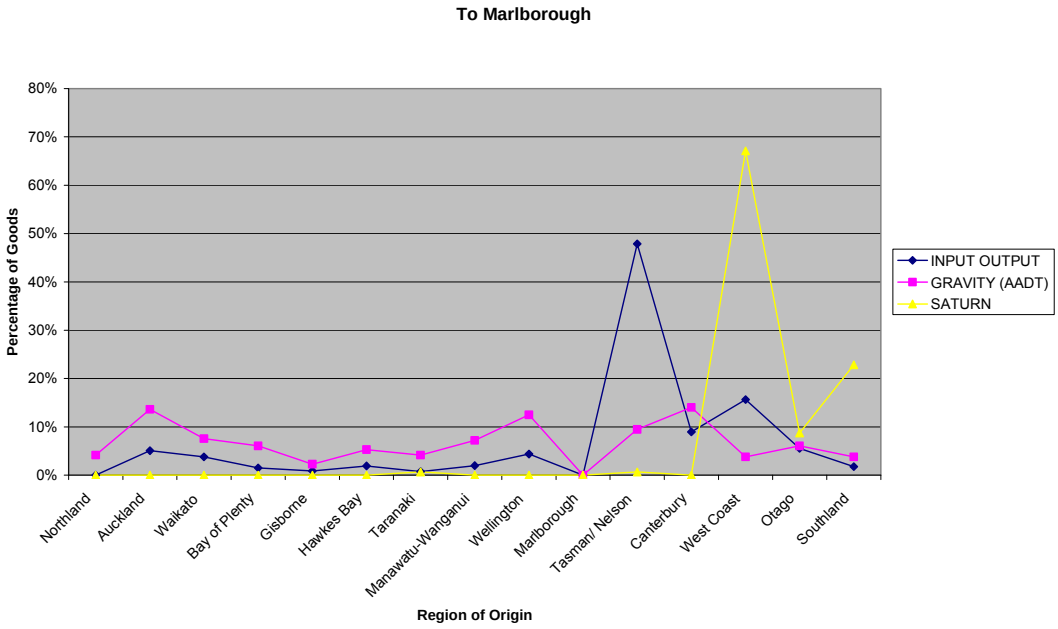

Figure 7.10 Origin of goods travelling to Marlborough, as predicted by all three models.

7.2.12 Tasman/Nelson

The IO model and the gravity model generate slightly different results for goods transported to the Tasman/Nelson region. The IO model indicated that 20% of goods transported to the Tasman/Nelson region originated in the West Coast, followed by 17% for Canterbury and 15% for Marlborough. This compares to the gravity model, where 14% of the goods arrived from both Canterbury and Auckland respectively, followed by 12% from Wellington. For all other regions, the differences between the IO model and the gravity model are within ±4%. The SATURN model gives quite different results, indicating that 69% of the goods transported originated in Southland, followed by 27% originating in Otago. The SATURN model indicates that 95% of the goods arriving into the Tasman/Nelson region are from within the South Island, compared to 35% and 65% respectively for the gravity and IO models.

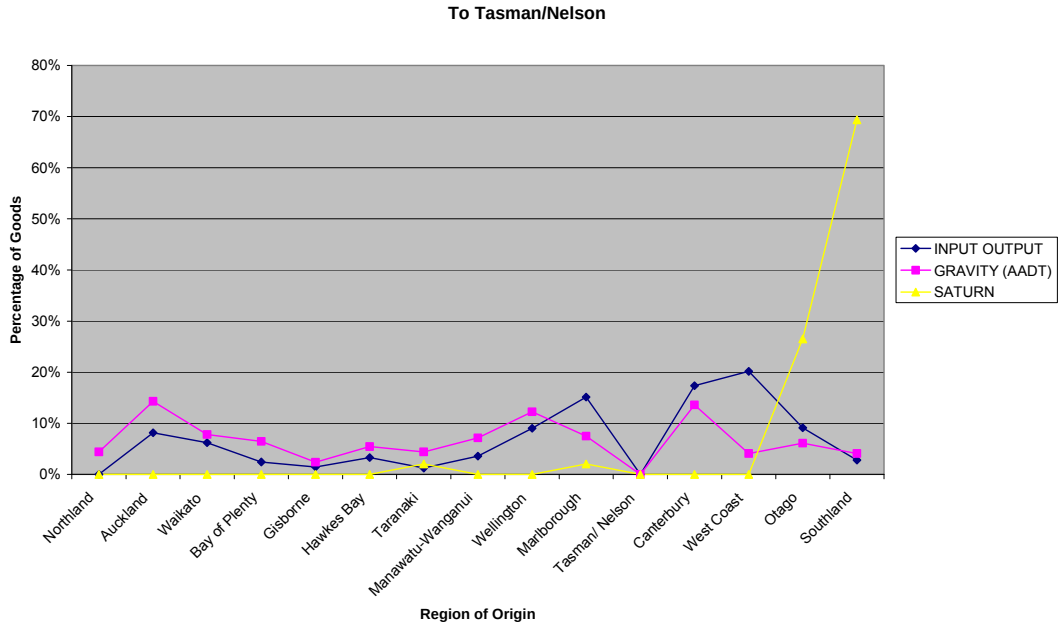

Figure 7.11 Origin of goods travelling to Tasman/Nelson, as predicted by all three models.

7.2.13 Canterbury

The IO and the gravity model generate quite different results for goods destined for Canterbury. The IO model suggests that 57% of goods arriving in Canterbury are from the West Coast, followed by 14% from Otago. This compares to 15% from Auckland, 12% from Wellington and 10% from Otago for the gravity model. For all other regions, the differences between the IO model and the gravity model are within ±6%. SATURN yields quite different results, indicating that 75% of the goods transported originate in Southland, followed by 28% from Otago. The SATURN model indicates that all of the goods arriving into Canterbury are from within the South Island compared to 33% and 86% respectively for the gravity and IO models.

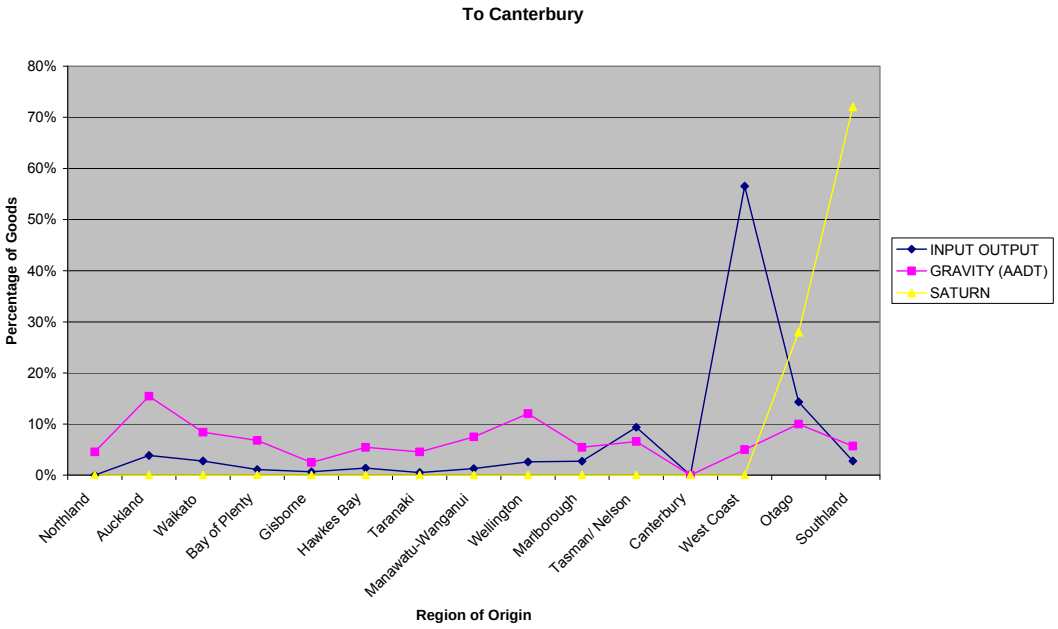

Figure 7.12 Origin of goods travelling to Canterbury, as predicted by all three models.

7.2.14 West Coast

For goods transported to the West Coast, both the IO and the gravity model generate results indicating that the largest percentage of goods transported originated in Canterbury (31% and 17% respectively). The IO model also suggests that a further 16% of goods arriving in the West Coast are from Otago. This compares to 13% from Auckland and 11% from Wellington in the gravity model. For all other regions, the differences between the IO model and the gravity model are within ± 5%. Once again, SATURN gives quite different results, indicating that 27% comes from Southland and 11% from Otago. The SATURN model indicates that all of the goods arriving in the West Coast are from within the South Island compared to 41% and 66% respectively for the gravity and IO models.

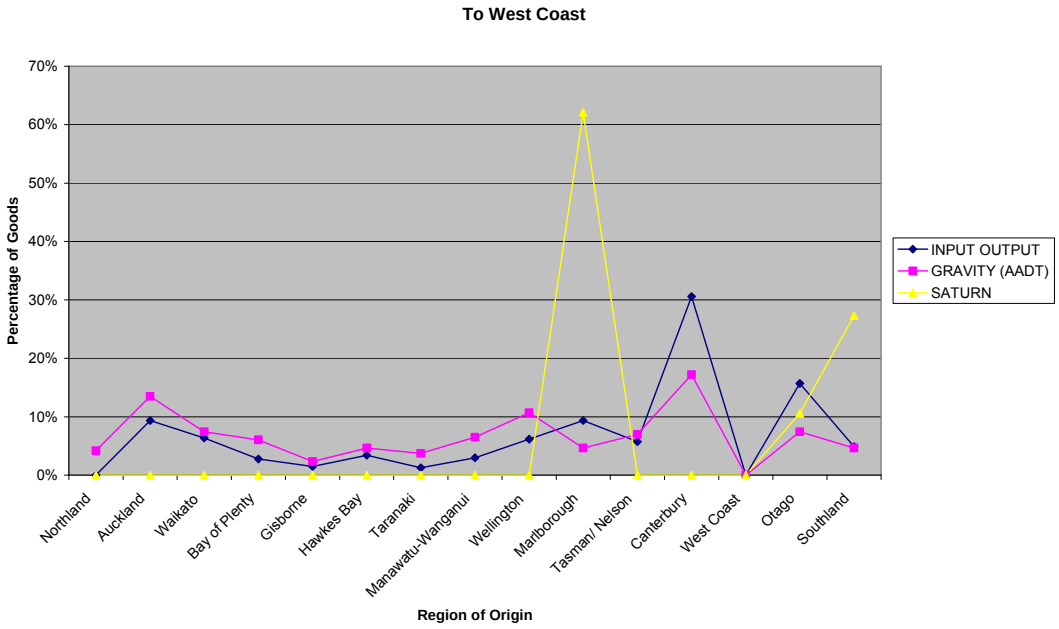

Figure 7.13 Origin of goods travelling to the West Coast, as predicted by all three models.

7.2.15 Otago

Both the IO and the gravity model generate results indicating that the largest percentage of goods transported to Otago originate in Canterbury (27% and 17% respectively). The IO model also suggests that a further 20% of goods arriving in Otago are from the West Coast, followed by 19% from Southland. This compares to 15% from Auckland and 10% from Wellington as suggested by the gravity model. For all other regions, the differences between the IO model and the gravity model are within ± 4%. SATURN gives quite similar results, indicating that 47% of the goods originate in Canterbury. This was followed by 16% of goods from the West Coast and 10% each from Tasman/Nelson and Marlborough respectively. The SATURN model indicates that 83% of the goods arriving into Otago are from within the South Island compared to 39% and 73% respectively for the gravity and IO models.

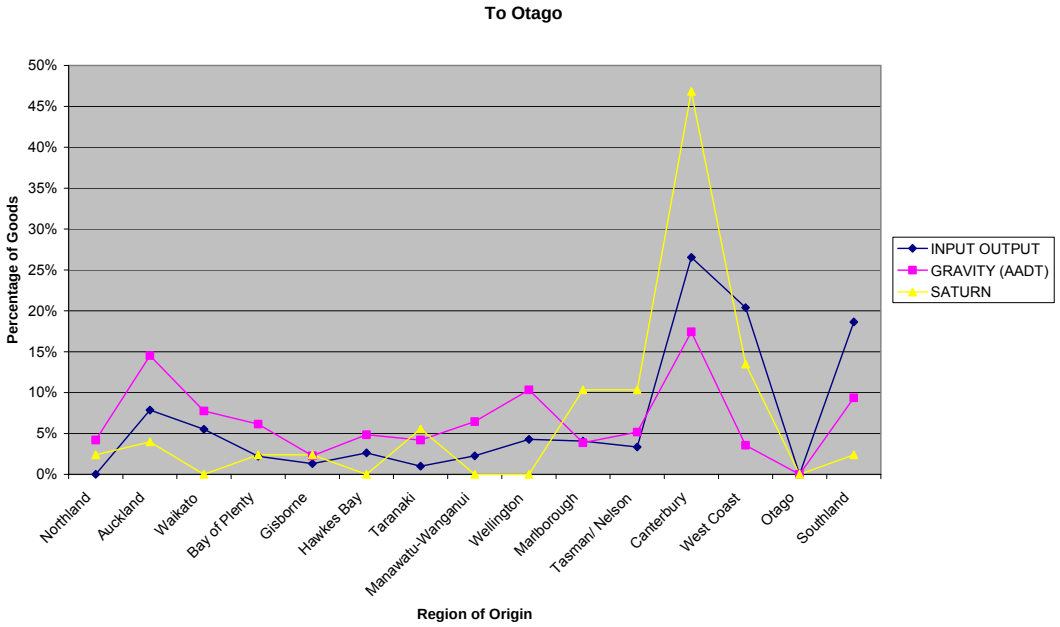

Figure 7.14 Origin of goods travelling to Otago, as predicted by all three models.

7.2.16 Southland

For goods transported to Southland, the IO and the gravity model generate different results. The IO model indicated that 43% of goods arrive from Otago, followed by 15% from Canterbury and 14% from the West Coast. For the gravity model, 15% of the goods arrive from Canterbury, followed by 14% for both Otago and Auckland, and 10% from Wellington. For all other regions, the differences between the IO model and the gravity model are within ±4%. SATURN differs again, indicating that 47% of the goods transported originated in Canterbury. This was a followed by 14% of goods from the West Coast and 11% from Marlborough and from Tasman/Nelson. The SATURN model indicates that 83% of the goods arriving into Southland are from within the South Island compared to 40% and 78% respectively for the gravity and IO models.

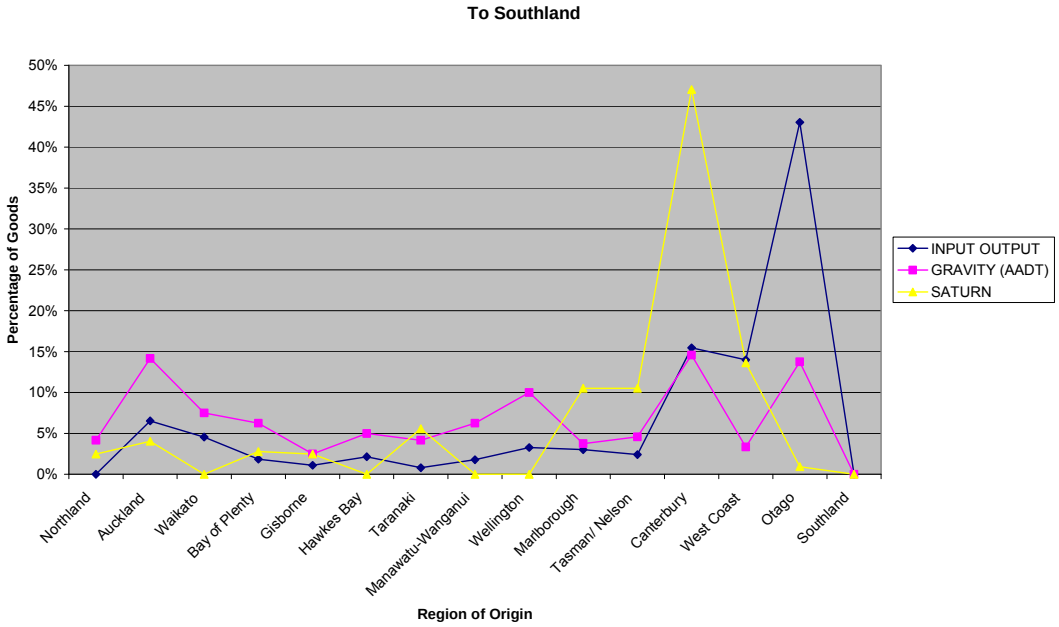

Figure 7.15 Origin of goods travelling to Southland, as predicted by all three models.

7.3. Comparing the percentages generated by the models

A summary of the percentage of goods travelling to each region from the North and South Islands as mentioned in the earlier discussion is shown below in Table 7.1 for the three models:

Table 7.1 Summary of percentage of goods breakdown

Destination region	Percentage of goods originating in the North Island			Percentage of goods originating in the South Island		
	IO	Gravity	SATURN	IO	Gravity	SATURN
Northland	81%	80%	98%	19%	20%	2%
Auckland	78%	78%	98%	22%	22%	2%
Waikato	82%	81%	100%	18%	19%	0%
Bay of Plenty	96%	81%	98%	4%	19%	2%
Gisborne	70%	78%	96%	30%	22%	4%
Hawkes Bay	78%	78%	100%	22%	22%	0%
Taranaki	75%	78%	95%	25%	22%	5%
Manawatu/Wanganui	68%	76%	100%	32%	24%	0%
Wellington	58%	70%	100%	42%	30%	0%
Marlborough	20%	63%	1%	80%	37%	99%
Tasman/Nelson	35%	65%	2%	65%	35%	98%
Canterbury	14%	67%	0%	86%	33%	100%
West Coast	34%	59%	0%	66%	41%	100%
Otago	27%	61%	17%	73%	39%	83%
Southland	22%	60%	17%	78%	40%	83%

The way to read the data is as follows: if Northland, for example, is considered, the IO model indicates that 81% of the goods arriving into Northland originate in the North Island and 19% originate in the South Island. The compares to an 80/20% split for the gravity model and a 98%/2% split for the SATURN model. The SATURN model's results differ significantly compared to the other two models. This is probably because of the constraints placed in the model by the Cook Strait crossing.

Another method of comparing the three models is to look at the overall traffic counts predicted by each of the models. The IO and the SATURN models give overall counts that are quite similar (1 018 360 compared to 1 666 500). Compared to the other two, the gravity model has a scaling issue that is unresolved, as the gravity model generates an annual total count of 18 071 910. It is clear from the graphs and discussion though that the IO model and the gravity model appear to have the closest match regarding the way that the vehicle trips are distributed across the country. The annual traffic count data for the three models are shown in Tables 7.2 to 7.4.

Table 7.2 IO model annual heavy vehicle counts

Origin	Destination															
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Marlborough	Tasman/ Nelson	Canterbury	West Coast	Otago	Southland	**Total**
Northland	0	220	40	50	0	10	10	10	20	0	0	10	0	0	0	**370**
Auckland	10 030	0	44 600	56 970	1060	5170	5500	6240	11 290	1340	840	6780	440	1980	1060	**153 300**
Waikato	3930	112 550	0	123 260	880	4790	5120	5400	9120	1000	640	4930	300	1390	740	**274 050**
Bay of Plenty	1270	22 860	11 890	0	470	1860	1660	2130	3500	400	250	1960	130	560	300	**49 240**
Gisborne	420	5530	2070	1610	0	1580	530	1250	2050	230	150	1160	70	330	180	**17 160**
Hawkes Bay	850	11 730	4970	2790	690	0	1520	4860	5890	510	340	2450	160	660	350	**37 770**
Taranaki	330	4590	1960	4680	90	560	0	1360	2080	190	130	900	60	250	130	**17 310**
Manawatu/ Wanganui	560	7540	2930	13 500	290	10 990	6980	0	18 220	520	370	2280	140	570	290	**65 180**
Wellington	760	10 020	3670	7750	350	2300	2180	7140	0	1160	930	4620	290	1080	530	**42 780**
Marlborough	410	4830	1640	930	160	810	820	1540	4680	0	1560	4860	440	1020	490	**24 190**
Tasman/ Nelson	320	3890	1350	770	130	690	690	1420	4820	12 670	0	16560	270	840	390	**44 810**
Canterbury	1050	11 950	3980	2290	390	1890	1900	3340	9210	2370	1790	0	1440	6690	2510	**50 800**
West Coast	1280	14 630	4820	2810	480	2330	2310	4020	10 870	4140	2080	99880	0	5140	2270	**157 060**
Otago	920	10 120	3260	1910	330	1510	1510	2470	6260	1470	940	25310	740	0	6980	**63 730**
Southland	340	3660	1180	690	120	530	530	850	2100	470	290	4920	230	4700	0	**20 610**
Total	**22 470**	**224 120**	**88 360**	**220 010**	**5440**	**35 020**	**31 260**	**42 030**	**90 110**	**26 470**	**10 310**	**176620**	**4710**	**25 210**	**16 220**	**1 018 360**

Table 7.3 Gravity model: annual heavy vehicle counts

Origin	**Destination**															
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Marlborough	Tasman/ Nelson	Canterbury	West Coast	Otago	Southland	**Total**
Northland	0	232 840	118 290	93 390	39 110	62 680	58 910	65 750	78 680	31 910	37 520	60 520	25 830	40 060	30 790	**976 280**
Auckland	359 880	0	551 420	390 580	142 230	232 880	224 010	237 510	278 350	109 070	127 440	203 900	87 040	133 560	102 200	**3 180 070**
Waikato	142 960	431 150	0	274 710	82 180	141 390	140 920	139 540	159 420	60 090	69 750	110 690	47 260	71 780	54 700	**1 926 540**
Bay of Plenty	104 340	282 350	253 980	0	75 990	114 680	100 400	112 380	127 390	48 310	56 140	89 190	38 080	57 920	44 170	**1 505 320**
Gisborne	30 520	71 820	53 070	53 080	0	50 990	28 830	44 310	49 380	18 650	21 650	34 380	14 680	22 300	17 000	**510 660**
Hawkes Bay	62 590	150 460	116 840	102 490	65 250	0	65 080	121 790	120 650	40 720	46 550	72 530	30 990	46 040	34 800	**1 076 780**
Taranaki	54 910	135 100	108 700	83 760	34 430	60 750	0	90 160	95 740	33 130	37 990	59 420	25 380	37 870	28 660	**886 000**
Manawatu/ Wanganui	71 040	166 030	124 750	108 670	61 340	131 770	104 500	0	213 680	57 320	64 150	97 660	41 740	60 480	45 300	**1 348 430**
Wellington	98 940	226 470	165 890	143 380	79 560	151 930	129 160	248 690	0	99 720	108 230	159 870	68 390	96 250	71 390	**1 847 870**
Marlborough	25 930	57 350	40 410	35 140	19 420	33 140	28 880	43 110	64 440	0	65 540	71 900	30 920	36 850	26 200	**579 230**
Tasman/ Nelson	34 460	75 720	53 010	46 140	25 480	42 810	37 430	54 530	79 040	74 070	0	86 120	43 600	47 450	34 320	**734 180**
Canterbury	76 840	167 500	116 300	101 360	55 930	92 220	80 930	114 760	161 410	112 330	119 060	0	109 880	160 810	104 910	**1 574 240**
West Coast	19 670	42 890	29 780	25 960	14 320	23 630	20 740	29 420	41 420	28 970	36 150	65 910	0	33 980	23 500	**436 340**
Otago	42 140	90 880	62 470	54 520	30 050	48 490	42 730	58 880	80 500	47 680	54 340	133 200	46 920	0	99 610	**892 410**
Southland	28 500	61 200	41 890	36 590	20 160	32 250	28 460	38 810	52 550	29 850	34 590	76 480	28 560	87 670	0	**597 560**
Total	**1 152 720**	**2 191 760**	**1 836 800**	**1 549 770**	**745 450**	**1 219 610**	**1 090 980**	**1 399 640**	**1 602 650**	**791 820**	**879 100**	**1 321 770**	**639 270**	**933 020**	**717 550**	**18 071 910**

Table 7.4 SATURN model: annual heavy vehicle counts

Origin	Destination															
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Marlborough	Tasman/ Nelson	Canterbury	West Coast	Otago	Southland	**Total**
Northland	0	300	42 600	42 900	9600	25 200	13 500	7800	17 400	0	0	0	0	900	2400	**162 600**
Auckland	300	0	69 600	70 200	15 600	41 400	22 200	12 600	28 500	0	0	0	0	1500	3900	**265 800**
Waikato	42 600	69 900	0	31 800	7200	300	0	0	0	0	0	0	0	0	0	**151 800**
Bay of Plenty	42 900	70 200	31 500	0	0	27 600	9900	8400	18 900	0	0	0	0	900	2700	**213 000**
Gisborne	9600	15 900	7200	0	0	7200	2100	17 700	17 700	0	0	0	0	900	2400	**80 700**
Hawkes Bay	25 200	41 700	300	27 900	7800	0	41 400	600	600	0	0	0	0	0	0	**145 500**
Taranaki	13 500	22 200	0	9900	2100	40 500	0	17 700	39 600	300	300	0	0	2100	5400	**153 600**
Manawatu/ Wanganui	7500	12 300	0	8100	17 700	600	17 100	0	600	0	0	0	0	0	0	**63 900**
Wellington	17 400	28 800	0	19 200	17 700	600	39 600	600	0	0	0	0	0	0	0	**123 900**
Marlborough	0	0	0	0	0	0	300	0	0	0	300	0	30 000	3900	10 200	**44 700**
Tasman/ Nelson	0	0	0	0	0	0	300	0	0	300	0	0	0	3900	10 200	**14 700**
Canterbury	0	0	0	0	0	0	0	0	0	0	0	0	0	17 700	45 600	**63 300**
West Coast	0	0	0	0	0	0	0	0	0	30 000	0	0	0	5100	13 200	**48 300**
Otago	900	1500	0	900	900	0	2100	0	0	3900	3900	17 700	5100	0	900	**37 800**
Southland	2400	3900	0	2700	2400	0	5400	0	0	10 200	10 200	45 600	13 200	900	0	**96 900**
Total	**162 300**	**266 700**	**151 200**	**213 600**	**81 000**	**143 400**	**153 900**	**65 400**	**123 300**	**44 700**	**14 700**	**63 300**	**48 300**	**37 800**	**96 900**	**1 666 500**

Conclusions and recommendations

The variability of the results between the three models illustrate that one particular overall approach is not the correct strategy of developing a national inter-regional freight model. A combination of gravity modelling an IO analysis is more likely to yield a representative model of inter-regional commercial vehicle flows.

Further research into the gravity model could include:

- construction of regional gravity models which include dummy variables for attractors/generators; and
- investigation into a spatial interaction model that uses a trip distribution or OD model which may align better with the IO analysis.

The IO analysis is also hindered in the fact that the IO tables are generally only updated and published every ten years.

In December 2006, Statistics New Zealand released their *Research Report of Regional Gross Domestic Product* (Statistics New Zealand 2006). The GDP estimates calculated in this research are considered to be of acceptable quality at a regional level but further analysis is required at an industry level. In July 2003, Statistics New Zealand released a *Regional Input-Output Study*, (Statistics New Zealand 2003c), which looked at the data sources required and recommends a development plan for compiling regional IO tables.

This current research concludes that a series of regional combined IO gravity models may be more appropriate than a national IO model or a national gravity model. Significant regional factors affect heavy vehicle traffic, e.g. attractors and generators such as major industry presence in a region, proximity to ports, airport and rail, and proximity to distribution hubs. These factors may have a significant effect on regional heavy vehicle traffic counts that are not being picked up in a single national model. However, research requiring this level of detail will require that more robust data are collected at a regional level.

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Appendix A: Estimating inter-regional freight flows from IO tables

A1 Introduction

The main objective of this research is to estimate the dollar value of inter-regional freight flows from regional input-output (IO) tables. This is part of a broader research programme being undertaken by Opus to estimate the number of truck movements along New Zealand's main roads and link this to economic activity. Thus any additional analysis that deduces truck movements from inter-regional trade flows (by value) is potentially useful to the wider research programme.

In fact to derive truck movements from trade value data one could adopt the following methodology:

1. Derive the weight of trade flows from the value of trade flows.
2. From the weight of flows, determine the tonne-kms on each route.
3. Allocate the tonne-kms of freight transport by mode.
4. Convert tonne-kms into the number of truck movements.

Our analysis estimates the dollar value of inter-regional trade, sorted by origin-destination (OD) pair and by the type of goods (classified by industry). We also convert the value data into weight data with the use of industry output prices, and then estimate tonne-kms. Step 3, however, brings us to the limit of what may be reasonably inferred from IO tables. Some inference on mode is possible, but it is neither robust, nor detailed. Step 4 is beyond the scope of this project.

A2. Methodology

A2.1 Basic premises

The essence of the methodology is to formulate the problem as a set of simultaneous equations augmented with:

- gravity-type equations so that the number of unknowns equals the number of equations; and
- inequality constraints to fill the missing degrees of freedom, with the system of equations solved by LP.

Consider a three-region model. This is large enough to illustrate the methodology, but not so large as to be cumbersome.

- Domestic regions: α, β, γ
- Overseas: Ω
- All New Zealand: Z

Regional IO tables show the exports that leave each region, but do not differentiate between destinations. Similarly, they show imports coming into each region, but not their origin. Export data are available by industry of source, and import data by industry of destination. Thus the type of goods and services imported by each industry are not known.

In very general terms, Table A1 shows the desired unknown flows (*).

Table A1 Desired unknown flows in a hypothetical three-region IO model.

	α	β	γ	Ω
α		*	*	*
β	*		*	*
γ	*	*		*
Ω	*	*	*	

The following are true for each industry *i:*

$$a_i\beta + a_i\gamma + a_i\Omega = a_i X \qquad \textit{Equation A1}$$

$$\beta_i a + \beta_i\gamma + \beta_i\Omega = \beta_i X \qquad \textit{Equation A2}$$

$$\gamma_i a + \gamma_i\beta + \gamma_i\Omega = \gamma_i X \qquad \textit{Equation A3}$$

where:
$\alpha_i X$ denotes total sales (from industry *i*) by region α to other regions and to overseas, as given in regional IO tables (a similar patter in followed by Equations A2 and A3).

$$a_i\Omega + \beta_i\Omega + \gamma_i\Omega = Z_i\Omega \qquad \textit{Equation A4}$$

Equation A4 states that the sum of all regional exports overseas from industry *i* must be equal to the total New Zealand exports from industry *i.*

For three industries and four regions – three domestic and one overseas – Equations A1–4 actually encompass 12 equations and 27 unknowns on the left hand side. As a general rule of thumb, *i* industries in *n* regions (comprising n-1 domestic regions and one overseas region) will require $(i \times n)$ equations and $(i \times [n-1]^2)$ unknowns for *i* industries in *n* regions.

$$\beta a + \gamma a + \Omega a = Ma \qquad \textit{Equation A5}$$

$$a\beta + \gamma\beta + \Omega\beta = M\beta \qquad \textit{Equation A6}$$

$$a\gamma + \beta\gamma + \Omega\gamma = M\gamma \qquad \textit{Equation A7}$$

$$\Omega a + \Omega\beta + \Omega\gamma = \Omega Z \qquad \textit{Equation A8}$$

Equation A5 states that imports from all source regions (of all types) used in region α are equal to total purchases from other regions and from offshore, as given in regional IO

tables, and so forth for Equations A6 and A7. Equation A8 states that the sum of all regional imports from overseas must be equal to total New Zealand imports.

Equations A5–A8 encompass 4 equations and 3 extra unknowns – the terms involving Ω on the left hand side. In general terms, *i* industries in *n* regions (comprising n-1 domestic regions and one overseas region) will require *n* equations and (n-1) unknowns.

Table A2 presents a schematic of Equations A1–A8.

Table A2 Schematic of Equations A1–A8

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
α1β	1													1		
α1γ	1														1	
α1Ω	1									1						
α2β		1												1		
α2γ		1													1	
α2Ω		1									1					
α3β			1											1		
α3γ			1												1	
α3Ω			1									1				
β1α				1												1
β1γ				1											1	
β1Ω				1						1						
β2α					1											1
β2γ					1										1	
β2Ω					1						1					
β3α						1						1				1
β3γ						1									1	
β3Ω						1						1				
γ1α							1									1
γ1β							1							1		
γ1Ω							1			1						
γ2α								1								1
γ2β								1						1		
γ2Ω								1			1					
γ3α									1							1
γ3β									1					1		
γ3Ω									1			1				
Ωβ													1	1		
Ωγ													1		1	
Ωα													1			1
	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=
RHS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Only the terms in Equations A1–A4 are directly useful for deriving freight movements. For example, $a_i\beta$ tells us something about the nature of the goods (i) being exported from region a to region β, but a term such as $a\beta$ in Equation A6 encompasses a whole collection of different goods being exported from region α for use in region β.
Equations A5–A8 could be differentiated by industry and final demand from the user perspective. However, identifying inter-regional trade by category of user (that is by each industry and type of final demand) is beyond the scope of the project.

The system above with i=3 and n=4 has 30 unknown variables but only 16 equations. Clearly, the system cannot be solved as a set of simultaneous equations. Two possible solutions would seem to exist:

- A number of other equations could be introduced to bring the number of (independent) equations up to the number of unknowns.
- By adding inequality constraints, it may be possible to set up the problem as a linear programming (LP) problem.

A2.2 Linear programming

No unknown can have a negative value, and therefore we have 30 constraints of the form X ≥0 or, more generally, $(i \times [n-1]^2) + (n-1)$ such constraints.

We also assume that the value of trade is inversely related to the distance between exporting and importing regions, and that the value of trade is directly related to some measure of economic mass of the regions such as population, gross output or gross domestic product (GDP). Conceptually, this is the same as the gravity model of inter-regional trade. That is, for trade (T) in a good i, between regions p and q, where d denotes distance (or more accurately the cost of transport) and M is some measure of regional economic mass:

$$T_{ipq} = \frac{\lambda M_p M_q}{d_{pq}^{\ 2}} (\forall i) \qquad \textit{Equation A9}$$

An LP approach differs from this by not imposing a uniform factor of proportionality λ. Also, while the squared term for distance is correct for gravitational force, the cost of transporting goods per unit of distance declines with distance, at least for a given mode of transport, and a single occurrence of loading and unloading. Thus the squared term is probably too powerful. Conservatively then, for each OD pair we calculate a scalar:

$$S_{ipq} = \frac{M_p M_q}{d_{pq}} (\forall i) \qquad \textit{Equation A10}$$

For the purposes of LP, the only requirement is to set equations of the form:

$T_{ipq} \geq T_{ipr}$ according to whether $S_{ipq} \geq S_{ipr}$ *Equation A11*

It is possible to add further *ad hoc* constraints such as setting cases to zero if trade in given goods between given regions are very likely to be zero or insignificant, combined

with a minimum trade threshold in all other cases. The IO tables are in $million, so a minimum of either zero (where known) or $1million could be sensible.

For regional economic mass *M*, we use regional gross output as estimated in the regional IO tables. This should be a better indicator of trade attraction than GDP or population.

As it stands, Equation A10 imposes symmetry in the form of $S_{ipq} = S_{iqp}$ and does not distinguish between industries (i.e. $S_{ipq} = S_{jpq}$). Neither of these features is desirable as both ignore the general precept that regions with large industries will tend to export goods from those industries. The following two equations are one way of formulating this precept.

$$M_p = GO_{ip} \qquad \textit{Equation A12}$$

$$M_q = \sum_i GO_{iq} - GO_{iq} \qquad \textit{Equation A13}$$

where: GO is gross output.

Equations A12 and A13 mean that exports of a given type rise with the size of the associated industry in the origin region, but fall with the relative size of that industry in destination regions. Note that Equations A10–A13 only determine *relative* trade flows. The *absolute* constraints are provided by Equations A1–A8.

Given the different factors that determine overseas trade and the close proximity of New Zealand's regions to one another compared to their proximity to other countries, the gravity model is not applied to overseas trade. Hence the number of S_{ipq} terms is $(i_x \{[n-1]^2 - [n-1]\})$, implying the same amount of Equation A11 inequality restrictions, including setting the smallest $S_{ipq} \geq 0$ for any given industry *i* and origin region *p*. In fact, these inequalities automatically incorporate the non-negativity constraints noted above for all unknowns, except those that relate to overseas trade. This reduces the number of non-negativity constraints to *([i+1] x [n-1])*.

The example above has three regions, α, β, and γ; and overseas region, Ω. Hence it has 18 inequality constraints plus 12 other non-negativity constraints. See Table A3 for a representation of the LP problem.

Table A3 Schematic of the linear programming problem.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
α1β	1													1			1				
α1γ	1														1		-1	1			
α1Ω	1									1											
α2β		1												1					1		
α2γ		1													1				-1	1	
α2Ω		1									1										
α3β			1											1							1
α3γ			1												1						-1
α3Ω			1									1									
β1α				1												1					
β1γ				1											1						
β1Ω				1						1											
β2α					1											1					
β2γ					1										1						
β2Ω					1						1										
β3α						1										1					
β3γ						1									1						
β3Ω						1						1									
γ1α							1									1					
γ1β							1							1							
γ1Ω							1			1											
γ2α								1								1					
γ2β								1						1							
γ2Ω								1			1										
γ3α									1							1					
γ3β									1					1							
γ3Ω									1			1									
Ωβ													1	1							
Ωγ													1		1						
Ωα													1			1					
	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	≥	≥	≥	≥	≥
RHS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0

An interesting question is whether trade in services is subject to the effects of distance in same way that trade in goods is. Some service trade involves people such as construction workers and business consultants moving across regional boundaries, so distance is relevant. Exports of energy are subject to transmission losses that increase with distance. For telecommunications, some service costs rise with distance and some do not. The latter encompass many consultancy services that are delivered via email and the internet (e.g. website development). Exports of restaurants and accommodation services are delivered in the region of origin, not in the region of destination, but even if the suppliers do not have to travel, the customers do.

An LP problem needs an objective function but regional trade has no obvious objective function. One cannot just maximise a given trade flow, as this would probably yield corner solutions with many other trade flows at zero. Ideally, we desire an objective function which, although it is technically maximised or minimised, is as tightly constrained as possible.

In the full model, all of the service industries are combined into a single industry. While service exports and imports are high, no freight is involved and thus they are not of interest to this study. Nevertheless, we do not discard services as their retention makes it easier to work with the IO data.

One possibility for an objective function is to minimise the value of inter-regional trade in services across all domestic OD pairs combined.

In the above example, if industry 3 was services, we would minimise:

$$\alpha_3\beta + \alpha_3\gamma + \beta_3\alpha + \beta_3\gamma + \gamma_3\alpha + \gamma_3\beta \qquad \textit{Equation A14}$$

Variations on this will probably need to be examined. For example the solution to Equation A14 might involve quite unrealistic relative values, which might in turn lead to dubious results for trade in goods.

A2.3 Simultaneous equations

Under the LP approach outlined above, the addition of Equations A12 and A13 allow S_{ipq} in Equation A10 to vary with every combination of good i, origin region p and destination region q. This is too general a specification if the problem is to be solved as a set of simultaneous equations as each trade flow T_{ipq} in Equation A11 is implicitly related to each S_{ipq} by a unique unknown scalar λ_{ipq}. We achieve no change in the relative number of unknowns and equations by simply replacing the T_{ipq} with the λ_{ipq}.

Less general specifications are required. Consider:

$$\frac{\lambda_{ipq}}{\lambda_{ipr}} = \frac{\lambda_{jpq}}{\lambda_{jpr}} \qquad \textit{Equation A15}$$

For example, if textile exports from Manawatu to Auckland were equal to twice the value of textile exports from Manawatu to Waikato, then relative food exports would also be in a ratio of 2:1, albeit with different absolute values.

Alternatively, if textile exports from Manawatu to Auckland were equal to one-third of the value of food exports from Manawatu to Auckland, then the ratio of textile to food exports from Manawatu to Waikato would also be 1:3, albeit with different absolute values to reflect different distances and economic weights.

In fact, Equation A15 turns out to be more restrictive than necessary, as it reduces the degrees of freedom from $(n-1)^2$ to $(n-1)$. A less restrictive option is presented in the next section.

A3. Model construction

The full regional IO dataset contains 15 domestic regions and 114 industries. To ensure a manageable problem and to avoid spurious accuracy, the number of industries is reduced to 17, but the number of regions is left unchanged as their classification is generally well aligned with geographical and economic differences, and the major roads between regions tend to run through the respective major cities and towns.

The cost of transport between regions is measured as the road travel times between the main cities and/or towns.[10] This is presumed to be a better proxy than a simple distance measure, but may need to be further refined. Table A4 lists the industries and Table A5 shows the relative travel times for each pairwise combination.

Table A4 Numbering for industry groups.

Number	Industry
1	Horticulture
2	Pastoral agriculture
3	Forests
4	Fishing
5	Mining
6	Meat processing
7	Dairy processing
8	Other food, beverages & tobacco
9	Textiles
10	Wood products
11	Paper products
12	Petroleum
13	Chemicals
14	Non-metallic products
15	Basic and fabricated metals
16	Equipment and machinery
17	Services

[10] This uses NZAA travel times plus 3.5 hours for Cook Strait.

Table A5 Travel times between regions (main town to main town) in hours.

Origin		Destination														
Region	**Town**	ND	AD	WO	BOP	GE	HB	TI	MW	WN	TN	MH	CY	WS	OO	SD
Northland	Whangarei	X	3.0	4.9	6.3	11.3	9.6	9.3	10.7	12.8	18.5	16.8	21.3	21.8	26.3	29.5
Auckland	Auckland		X	1.9	3.3	8.3	6.6	6.3	7.7	9.3	14.9	13.2	17.8	18.3	22.8	25.9
Waikato	Hamilton			X	1.9	6.5	4.7	4.4	5.8	7.5	13.2	11.4	16.0	16.5	21.0	24.2
Bay of Plenty	Tauranga				X	5.0	4.9	5.7	6.0	8.0	13.7	11.9	16.5	17.0	21.5	24.7
Gisborne	Gisborne					X	3.4	10.4	6.1	8.3	13.9	12.2	16.8	17.3	21.8	24.7
Hawkes Bay	Napier						X	6.3	2.7	4.8	10.5	8.8	13.3	13.8	18.3	21.5
Taranaki	New Plymouth							X	3.6	5.2	10.8	9.1	13.7	14.2	18.7	21.8
Manawatu/ Wanganui	Palmerston North								X	2.2	7.8	6.1	10.7	11.2	15.7	18.8
Wellington	Wellington									X	5.7	3.9	8.5	9.0	13.5	16.7
Tasman/Nelson	Nelson										X	1.8	6.3	4.6	11.1	14.3
Marlborough	Blenheim											X	4.6	5.1	9.6	12.8
Canterbury	Christchurch												X	4.2	5.0	8.2
West Coast	Greymouth													X	8.2	11.3
Otago	Dunedin														X	3.2
Southland	Invercargill															x

Abbreviations used in Table A5:

ND: Northland
AD: Auckland
WO: Waikato
BOP: Bay of Plenty
GE: Gisborne
HB: Hawkes Bay
TI: Taranaki
MW: Manawatu/Wanganui
WN: Wellington
TN: Tasman/Nelson
MH: Marlborough
CY: Canterbury
WS: West Coast
OO: Otago
SD: Southland

Even with only 17 industries, we have 3840 unknown variables and 4128 equations, comprising 288 equalities and 3840 inequalities and non-negativity constraints – a formidable LP problem.

In fact, this problem is too large for our LP package as it involves over 15 million cells. We have experimented with smaller datasets. Regrettably, but not surprisingly, this experimentation has demonstrated that a sensible LP solution is improbable. Consider the following very simple LP problem for exports from one industry in a single region to all other regions. Clearly, this means that some cross-industry constraints are discarded, which raises the relative number of degrees of freedom. However, this does not undermine the argument.

Ignoring the non-zero constraints, the problem looks something like Table A6, using Auckland as an example with fifteen other regions.

Table A6 Exports from an Auckland industry to other New Zealand regions (simplified).

Line	Destination														Constraint	
	N	**K**	**B**	**G**	**H**	**T**	**M**	**W**	**E**	**R**	**C**	**S**	**O**	**U**		
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	=	X
2		1	-1												≥	0
3			1					-1							≥	0
4	-1							1							≥	0
5	1										-1				≥	0
6							-1				1				≥	0
7						-1	1								≥	0
8					-1	1									≥	0
9					1									-1	≥	0
10													-1	1	≥	0
11									-1				1		≥	0
12				-1					1						≥	0
13				1						-1					≥	0
14										1		-1			≥	0
15												1			≥	0

Abbreviations used in Table A6:

N: Northland
K: Waikato
B: Bay of Plenty
G: Gisborne
H: Hawkes Bay
T: Taranaki
M: Manawatu/Wanganui
W: Wellington
E: Tasman/Nelson
R: Marlborough (including Kaikoura)
C: Canterbury
S: West Coast
O: Otago
U: Southland

Line 1 represents Equation A1, the net of exports going offshore. Lines 2–15 are all inequality constraints based on Equations A10–A13. They imply that Auckland's exports to Waikato exceed Auckland's exports to Bay of Plenty, exports to Bay of Plenty exceed exports to Wellington, and so on, with exports to the West Coast being the smallest.

It is readily apparent that we have no sensible objective function within the context of such a partial approach. In the general case (of i =17 industries) one must rely on the cross-industry constraints (Equations A5–A8) to obtain non-trivial solutions. Unfortunately, the information content of these equations is not particularly rich, serving essentially to satisfy some aggregation constraints. This means that a plausible (non-trivial) solution of the problem is dependent on the Equation A11 inequalities, which, as shown above, are unlikely to be able to generate anything other than trivial solutions. In

fact, the example with i=3 industries and n=4 regions has multiple solutions, so the problem is degenerate.
Hence, we adopt a simultaneous equation approach, with the following additional assumptions to yield a solvable system.

- **Regional exports overseas by industry i are distributed *pro rata* with all regional exports by industry *i*** (to overseas and other New Zealand regions), such that the sum of regional exports of type *i* equals New Zealand exports of type *i*. For example, if Hawkes Bay accounts for 50% of all exported apples, then it is assumed to account for 50% of apples exported offshore. Using the notation of the previous section and region α as an example:

$$a_i\Omega = Z_i\Omega * a_iX /(a_iX + \beta_iX + \gamma_iX) \qquad \textit{Equation A16}$$

This adds another 255 *(i x [n-1])* such equations. The example in the previous section has nine extra equations.

- **Subtracting Equation A16 from Equation A1 yields total exports from region α to other domestic regions,** i.e.:

$$a_i\beta + a_i\gamma = a_iX - a_i\Omega \qquad \textit{Equation A17}$$

Again, we have 255 *(i x [n-1])* such equations. To determine the variables on the left hand side, we make use of the gravity model parameter S_{ipq}. Again using region α as an example:

$$\lambda_{i\alpha\beta} = S_{i\alpha\beta} /(S_{i\alpha\beta} + S_{i\alpha\gamma}) \qquad \textit{Equation A18}$$

$$a_i\beta = \lambda_{i\alpha\beta}(a_iX - a_i\Omega) \qquad \textit{Equation A19}$$

Equation A18 normalises S_{ipq} for a given industry *i* and origin region *p*, which are then used in Equation A19 to produce the domestic inter-regional trade flows. More generally, for *i* industries and *n* regions (including the overseas region), we have 3570 (*i x [n-1] x [n-2])* ratios of the form of Equation A18 and hence the same number of Equations A19.

The total number of equations is now 4113 (288 of Equations 1–8, plus 255 of Equations A16–A17, plus 3570 of Equations A19) compared to 3840 unknowns, implying over-determination of the system. In fact, 273 equations are linear combinations of other equations, resulting in exactly 3840 independent equations as desired. The redundant equations are as follows:

- Total exports by a given industry from all regions (Equations 1-3) must be equal to exports offshore by that industry (Equation 4) plus exports to other domestic regions (Equation 19). Thus, one equation for each industry is redundant and we have 17 (*i*) equations altogether.
  In the 3570 equations like Equation A18 that define λ_{ipq}, for any given *i* and *p,* one equation is always redundant through the normalisation constraint (i.e.

$\sum_q \lambda_{ipq} = 1$). This means that 255 *(i x [n-1])* equations like Equation A19 are unnecessary.

- Finally, because total exports minus exports overseas must be equal to total imports less imports from overseas ($Exports_{total} - Exports_{overseas} = Imports_{total} - Imports_{overseas}$), one other equation is redundant. It is convenient for this to be Equation A8.

The final system of equations for the example with i=3 industries and n=4 regions is shown in Table A7. This system has successfully been solved using the matrix inversion method for a set of simultaneous equations relating to the full system with i=17 and n=16 – and 3570 equations. However, it is less cumbersome to solve the equations sequentially in a spreadsheet. This is shown in the spreadsheet IRtrade.xls, presented as Appendix B in Jewell et al. 2007.

Table A7 Schematic of the simultaneous equation problem (shaded lines represent redundant equations).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
α1β	1													1			1				
α1γ	1														1		1				
α1Ω	1									1											
α2β		1												1				1			
α2γ		1													1			1			
α2Ω		1									1										
α3β			1											1					1		
α3γ			1												1				1		
α3Ω			1									1									
β1α				1												1				1	
β1γ				1											1					1	
β1Ω				1						1											
β2α					1											1					1
β2γ					1										1						1
β2Ω					1						1										
β3α						1										1					
β3γ						1									1						
β3Ω						1						1									
γ1α							1									1					
γ1β							1							1							
γ1Ω							1			1											
γ2α								1								1					
γ2β								1						1							
γ2Ω								1			1										
γ3α									1							1					
γ3β									1					1							
γ3Ω									1			1									
Ωβ													1	1							
Ωγ													1		1						
Ωα													1			1					
	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=
RHS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Table A7 cont. Schematic of the simultaneous equation problem (shaded lines represent redundant equations).

Variable	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
α1β					1																	
α1γ						1																
α1Ω																						
α2β							1															
α2γ								1														
α2Ω																						
α3β									1													
α3γ										1												
α3Ω																						
β1α											1											
β1γ												1										
β1Ω																						
β2α													1									
β2γ														1								
β2Ω																						
β3α	1														1							
β3γ	1															1						
β3Ω																						
γ1α		1															1					
γ1β		1																1				
γ1Ω																						
γ2α			1																1			
γ2β			1																	1		
γ2Ω																						
γ3α				1																	1	
γ3β				1																		1
γ3Ω																						
Ωβ																						
Ωγ																						
Ωα																						
	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=
RHS	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

On the first iteration of the model, imports from overseas into the Waikato region were negative because of the large value of service imports by Waikato from Auckland. Hence, the travel time factor in Equation A10 was discarded for all trade in services.

For New Zealand as a whole, the IO table records re-exports of $0.7 million compared to total imports and exports of $38.1 million and $41.1 million respectively. These are goods that enter New Zealand but are exported to other countries without any transformation.

Fuel carried by international airlines is an example. We ignore re-exports in this analysis. Also, note that there are no re-exports between regions. The method used to estimate the regional IO tables does not allow for their imputation. However, the estimation of truck movements will allow for the situation where trade between any two regions entails the transport of goods through a third region.

A4. From value to physical units

The next stage in the estimation of inter-regional transport flows is to convert the dollar value of inter-regional flows into physical units such as tonnes or cubic metres. The method is as follows:

1. From the results already presented, we have the dollar value of inter-regional flows between all regional main centres (Box 1 in Figure A1).
2. Divide the values of inter-regional trade by average prices per tonne or cubic metre for each type of good (industry) to obtain each inter-regional trade flow in terms of tonnes or cubic metres (Boxes 2 and 3).

We address Boxes 4–8 in later sections.

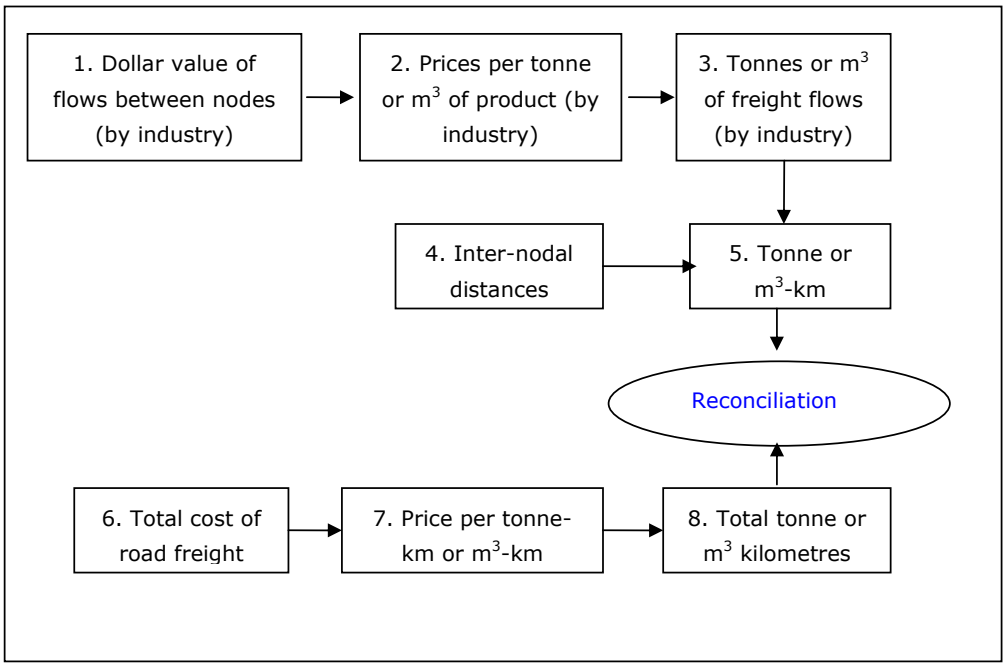

Figure A1 Inter-regional trade flows: converting from values to tonne-kms.

To convert values of inter-regional trade into physical units, we ideally require a set of industry gross output prices – the absolute price levels that underlie the Producers' Price Index (PPI) (Outputs) series published by Statistics New Zealand (Statistics New Zealand 2007). Unfortunately, this information is classed as confidential by Statistics New Zealand and is unobtainable. We have, however, been able to obtain value and

weight (tonnes) figures for exports and imports at the two-digit Harmonised System (HS) Classification level (about 90 commodities) for the year ended March 2000/01, the year to which the regional IO tables pertain. While mapping from commodities to industries is not perfect, with only 16 goods industries, the scope for substantial error is small.

A more important consideration is the assumption that export and import prices are reasonable proxies for the prices of similar goods that are traded within New Zealand. This is not so much a case of assuming equivalent prices for equivalent specific goods (which is reasonably uncontentious), but rather that the composition of the basket of goods produced by each industry is much the same whether that basket is traded domestically or traded overseas.

For 10 out of 16 industries, we assume that the export price is a reasonable proxy for the gross output price. The other six cases are dealt with as follows:

- **Pastoral agriculture:** Only a single HS code can be attributed to pastoral agriculture; HS 01 Live Animals. This consists primarily of valuable animals such as horses, leading to an average price of $32,600/tonne. Domestic trade is mostly of less valuable animals, raw wool and liquid milk. Using information from Agrifax, we have set the mean price for pastoral output at $2,500/tonne. Pastoral products account for an estimated 15% by value of inter-regional goods trade.
- **Wood products:** The export classification combines logs with other wood products. Hence the import price is used for other wood products as log imports are negligible.
- **Petroleum:** Imported petroleum products are probably a better proxy for petroleum products moving around New Zealand than are exported petroleum products.
- **Chemicals:** We use the average of the import and export prices, which differ by about 50%.
- **Non-metallic products:** Exports of these products are extremely high value and many are probably transported by air. The import price, which is about 15% of the export price, is probably a better price for domestic non-metallic products trade, which are mostly concrete and related products.
- **Equipment and machinery:** We use the average of the import and export prices, which differ by less than 10%.

The final set of prices is shown in Table A8. As an indication of the volatility of these prices, data are also shown for 1995/96 (the year of the underlying IO tables) and for 2003/04 (the latest March year available at the time of writing). Interestingly, the mean price for pastoral agriculture (live animals) is much less than the unadjusted $32,600/tonne for 2000/01. For the purposes of sensitivity testing, a ±10% change in price would seem reasonable for most industries.

Table A8 Industry gross output prices per tonne in 2000–2004.

Industry	Year		
	2000/01	1995/96	2003/04
Horticulture	$1,400	$1,190	$1,340
Pastoral agriculture	$2,500	$3,680	$13,120
Forests	$270	$220	$210
Fishing	$5,630	$3,840	$3,720
Mining	$70	$40	$70
Meat processing	$5,020	$3,000	$4,630
Dairy processing	$3,820	$3,200	$2,730
Other food, beverages and tobacco	$1,850	$1,630	$1,790
Textiles	$7,460	$7,140	$7,020
Wood products	$2,740	$2,150	$2,230
Paper products	$1,090	$970	$670
Petroleum	$540	$250	$390
Chemicals	$1,590	$1,250	$3,410
Non-metallic products	$1,980	$2,000	$1,470
Basic and fabricated metals	$2,310	$1,820	$1,690
Equipment and machinery	$21,280	$16,500	$16,810

The resultant trade flows in thousand tonnes are shown in Tables A9 and A10. In total, an estimated 17.9 million tonnes were traded regionally. The Auckland region is the largest importing region (by weight) by far, accounting for about one third of the total. Waikato is the largest exporting region, but with only around 20% of the total.

Table A9 Value of inter-regional trade flows (in thousands of dollars)

Origin	Destination																
	NL	AK	WK	BOP	GB	HB	TK	MW	WG	TN	MB	CY	WS	OO	SL	Total in NZ$	Overseas
Northland	0	793813	142399	66660	6442	29681	30507	36902	68010	9073	5579	46951	3071	14130	7632	1206852	1075888
Auckland	341891	0	1517466	5167749	36146	175712	186199	211668	385194	45607	28642	229285	15337	67612	36113	3793320	5077937
Waikato	63384	1602991	0	281153	14285	77649	0827	86451	150148	16387	10472	80054	5123	22498	11639	2503063	3190603
Bay of Plenty	32274	582796	301767	0	11997	47186	41751	54049	89483	10063	6428	49731	3283	14257	7580	1252644	1799740
Gisborne	9469	126766	46741	36999	0	35828	11973	28065	46950	5195	3279	26261	1699	7463	3918	390606	367668
Hawkes Bay	22379	307096	130582	73225	18049	0	39641	126541	154656	13263	8735	63657	4214	17182	8926	988145	1544614
Taranaki	17635	246359	105444	49684	4768	30320	0	73387	112913	10373	6863	48605	3161	13232	6754	732500	1727450
Manawatu/ Wanganui	20488	279204	107044	62769	10614	93870	69874	0	362498	19127	13603	83529	5341	20988	10418	1159367	1421611
Wellington	22899	304375	110731	62531	10520	69397	65393	214891	0	35154	28208	139280	8924	32705	15987	1120996	1239220
Tasman/ Nelson	10401	122299	41563	23750	3926	20199	20588	38815	119291	0	38609	122631	11363	25777	12298	611509	747379
Marlborough	6657	79870	27839	15782	2616	14016	14234	28989	99531	40518	0	96506	5927	17219	7944	457646	569097
Canterbury	43820	497687	165743	95638	16364	78616	78677	138530	384875	99296	74736	0	61185	277875	103707	2116750	3366363
West Coast	4956	57219	18608	10906	1864	9012	8835	15521	42626	15996	8006	105527	0	19951	8734	327763	413679
Otago	13749	152195	48792	28624	4913	22064	22210	36535	94498	21904	13949	289585	11985	0	101302	862304	1577429
Southland	11724	126705	40518	23811	4136	17935	17978	29064	72631	163121	10068	168823	8308	160269	0	708282	1605093
Total	621724	5282375	2805236	1348282	146640	721485	688686	1119408	2183306	358267	257178	1550426	1448922	710861	342951	18285747	25722770
Services	1341139	4406974	3608906	1923558	377665	1529751	1438165	1757708	1532215	855960	570815	3840342	405840	1669012	1473491	26731542	
Overseas	1606000	11610 804	1101403	1373030	519265	1108924	1692176	1378868	5495473	825587	433895	3618309	310981	1741316	1104266	33920298	

Table A10 Weight of inter-regional trade flows (tonnes)

Origin	**Destination**															**Total**
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Tasman/ Nelson	Marlborough	Canterbury	West Coast	Otago	Southland	
Northland	0	1333	242	112	11	50	52	63	114	15	9	79	5	24	13	2125
Auckland	218	0	969	329	23	112	120	136	245	29	18	147	10	43	23	2423
Waikato	89	2198	0	390	20	108	115	122	206	23	15	111	7	31	17	3450
Bay of Plenty	28	503	261	0	10	41	36	47	77	9	6	43	3	12	7	1083
Gisborne	9	126	47	37	0	36	12	29	47	5	3	26	2	8	4	392
Hawkes Bay	19	260	110	62	15	0	34	108	130	11	8	54	3	15	8	836
Taranaki	7	100	42	20	2	12	0	29	45	4	3	20	1	5	3	294
Manawatu/ Wanganui	12	168	65	38	6	57	43	0	218	12	8	51	3	13	6	701
Wellington	17	221	81	45	8	51	48	158	0	26	21	102	6	24	12	819
Tasman/ Nelson	9	107	36	21	3	18	18	34	104	0	35	108	10	23	11	537
Marlborough	7	87	30	17	3	15	15	31	107	45	0	105	6	19	9	497
Canterbury	23	261	87	50	8	41	41	73	201	52	39	0	31	146	55	1107
West Coast	29	329	108	63	11	52	52	90	244	93	47	611	0	115	51	1896
Otago	20	226	73	43	7	34	34	55	140	33	21	436	17	0	156	1295
Southland	7	81	26	15	3	12	12	19	46	10	6	109	5	104	0	454
Total	495	6000	2179	1241	131	640	633	993	1925	367	239	2003	109	581	373	17907

A5. Trade in tonne-kms

While the previous section delivered an estimate of the weight of goods transported between each pair of regions, it does not by itself produce an estimate of the number of tonne-kms of freight that is actually transported between nodes on the network (i.e. between regional main centres). For example, exports from Northland to Hawkes Bay need to pass through the Auckland and Waikato regions, implying transport between four nodes: Whangarei to Auckland, Auckland to Hamilton, and Hamilton to Napier. This is a distance of some 600 km, so each tonne of freight between Northland and Hawkes Bay represents 600 tonne-kms.

We now need to address Boxes 4 and 5 in Figure A1. Tables A11–A12 show regions that are defined as contiguous for the purposes of estimating tonne-kms transported by road. These are indicated by a check mark in the relevant cells in Table A11, which enables each inter-regional journey to be separated into a path of contiguous inter-nodal journeys. Clearly, this will not always be correct as journeys may take in other regional centres, and the shortest distance between two points is not always the optimum path. Also there are some *ad hoc* adjustments. For example, freight from Bay of Plenty to Manawatu/Wanganui technically passes through Waikato, but it is plainly silly to treat this as a flow from Tauranga to Hamilton to Palmerston North. Instead, a direct link between Bay of Plenty (Tauranga) and Manawatu/Wanganui (Palmerston North) is assumed.

Table A11 Matrix showing contiguous regions within New Zealand.

Origin	Destination														
	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawkes Bay	Taranaki	Manawatu/ Wanganui	Wellington	Tasman/ Nelson	Marlborough	Canterbury	West Coast	Otago	Southland
Northland		√													
Auckland	√		√												
Waikato		√		√		√	√	√							
Bay of Plenty			√		√	√		√							
Gisborne				√		√									
Hawkes Bay			√	√	√			√							
Taranaki			√					√							
Manawatu/ Wanganui			√	√		√	√		√						
Wellington								√			√				
Tasman/ Nelson											√	√	√		
Marlborough									√	√		√	√		
Canterbury										√	√		√	√	
West Coast										√	√	√			
Otago												√			√
Southland														√	

Table A12 Inter-nodal distances between main centres within New Zealand.

Journey	Distance (km)
Northland–Auckland	169
Auckland–Waikato	126
Waikato–Bay of Plenty	106
Waikato–Hawkes Bay	295
Waikato–Manawatu/ Wanganui	411
Waikato–Taranaki	231
Bay of Plenty–Gisborne	295
Bay of Plenty–Hawkes Bay	299
Bay of Plenty–Manawatu/Wanganui	415
Gisborne–Hawkes Bay	215
Hawkes Bay–Manawatu/Wanganui	178
Taranaki–Manawatu/Wanganui	234
Manawatu/Wanganui–Wellington	145
Wellington–Marlborough	128
Marlborough–Tasman/Nelson	116
Marlborough–Canterbury	308
Tasman/Nelson–West Coast	290
Tasman/Nelson–Canterbury	424
Canterbury–West Coast	258
Canterbury–Otago	362
Otago–Southland	217

As shown in Figure A2, New Zealand contains 22 possible contiguous inter-nodal trips.

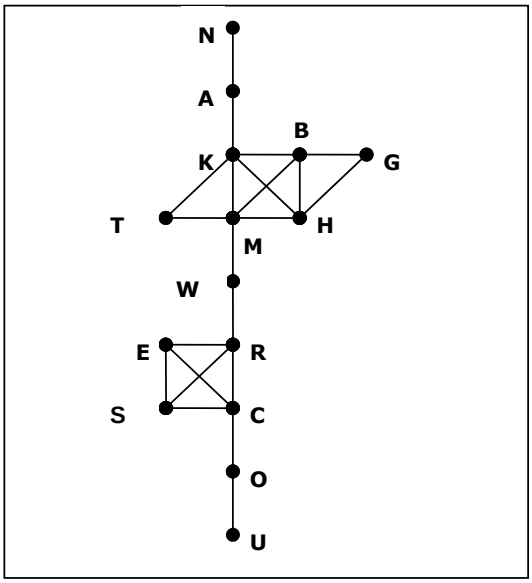

Figure A2 Contiguous freight nodes within New Zealand.
Abbreviations are as given in Table A6.

Given the trip distances and the number of tonnes being transported between regions (from Table A10), the number of tonne-kms of freight transported on each route is easily determined. This is shown in Table A13.

Table A13 Tonne-kms of freight transported between regional nodes within New Zealand.

Trip	Million tonne-km	Share
Whangarei–Auckland	443	0.056
Auckland–Hamilton	1000	0.126
Hamilton–Tauranga	203	0.026
Hamilton–Napier	195	0.024
Hamilton–Palmerston North	1486	0.187
Hamilton–New Plymouth	114	0.014
Tauranga–Gisborne	85	0.011
Tauranga–Napier	31	0.004
Tauranga–Palmerston North	205	0.026
Gisborne–Napier	51	0.006
Napier–Palmerston North	151	0.019
New Plymouth–Palmerston North	101	0.013
Palmerston North-Wellington	743	0.093
Wellington–Blenheim	569	0.072
Blenheim–Nelson	65	0.008
Blenheim–Christchurch	843	0.106
Blenheim–Greymouth	347	0.044
Nelson–Greymouth	30	0.004
Nelson–Christchurch	100	0.013
Christchurch–Greymouth	214	0.027
Christchurch–Dunedin	791	0.099
Dunedin–Invercargill	180	0.023
TOTAL	**7947**	**1.000**

In total, inter-regional trade entails 7947 million tonne-kms of transport, 19% of which is on the Waikato–Manawatu route, with the Auckland–Waikato route being ranked second with 13% of total tonne-kms.

One further factor must be considered: not all inter-regional freight is transported by road. We address this is the following section.

A6. Freight mode

A6.1 Freight margins

With reference to Figure A1, Box 5 gives us an estimate of the total tonne-kms of inter-regional trade on the assumption that it is all transported by road. While the use of rail and or coastal shipping may not have much impact on this total, we do not know how much of the 8000 million tonne-km actually travels by road. Air transport is unlikely to be significant as a share of inter-regional freight by weight. We also assume, for example, that freight is not transported by boat from Greymouth to Christchurch.

The IO tables used in this analysis identify road freight as a separate industry, and rail and water as another industry. Rail and water are not separated from each other for confidentiality reasons.

Where a buyer pays for the transport of goods, the cost of the transport (the transport margin) is shown as an input into the industry or final demand category pertaining to the buyer (see Table A14). The same applies if the transport margin is paid by the seller.

Table A14 Classification of transport margins in regional IO tables.

Transport company resident in:	Seller pays transport margin	Buyer pays transport margin
Origin region	local–local	import for destination region, export for origin region
Destination region	import for origin region, export for destination region	local–local
Third region	import for origin region, export for third region	import for destination region, export for third region

Unfortunately, it is not possible to infer which situation applies when. For any trade in a given commodity between two regions, we cannot identify from regional IO tables who pays for the transport, where the transport company is located, nor what mode of transport is used. For example, for a case of oranges sent from Kerikeri in Northland to New Plymouth in Taranaki, we cannot tell from IO data whether the oranges went by road or rail/ship, who (buyer or seller) paid the transport cost, nor where the transport company was based.

Using regional IO data on transport margins by industry does not provide much information on what type of mode is used to transport inter-regional trade of each type of good (industry). The most that can be gleaned from IO tables are a few totals, as summarised in Table A15.

With regard to the first category, clearly all of the road transport occurs in New Zealand. We assume that this is entirely allocated to goods within a given region being carried to that region's air or sea ports. This is likely to be an over-statement, but the relative size of this component is too small to be significant.

Road freight transport in the third category is, unfortunately, a large value. It is impossible to allocate it to the use of a local transport company to moves goods within its own region, or to the use of a local transport company to move goods into or out of the region where the paying party is the importer or exporter respectively. This includes New Zealand companies paying for the transport component of international exports and imports.

Table A15 Freight margins in 2000/01* (in $thousands).

Category	Description	Road	Rail/Water	Total
1	FOB freight margins paid by foreign buyers plus freight transport beyond New Zealand paid by foreign buyers	82,290	857,140	939,430
2	Freight margins for inter-regional trade where transport company resides in same region as seller and the buyer pays, or transport company resides in same region as buyer and seller pays, or transport company is in neither region.	297,726	448,598	746,324
3	Intra-regional freight margins plus inter-regional (including offshore) freight margins where transport company is in same region as paying party.	3,453,184	843,392	4,296,576
	Total	**3,833,200**	**2,149,130**	**5,982,330**
	Less intra-industry sales	818,290	321,850	1,140,140
	Final total	**3,014,910**	**1,827,280**	**4,842,190**

*Source: IO tables

With respect to road transport, excluding intra-industry transactions and transport margins that are clearly identified as pertaining to international exports leaves $2932m. This assumes that the overlap between export activity and intra-industry sales is negligible.

A similar calculation for rail/water leads to $970 million, from which another $140 million worth of passenger transport[11] may be subtracted, leaving $830 million. Road transport, therefore, accounts for about 78% of the cost of surface transport. In tonne-kms, however, the road's share is probably less.

A6.2 Tonne-kms by mode

Transit New Zealand (2001) estimates a cost per tonne-km of road transport of $0.120 for 1999. The PPI (Output) for road transport raises this to $0.128 for 2000/01. Thus the implied amount of freight moved by road in 2000/01 is approximately 22 900 million tonne-km. Refer to Boxes 6–8 in Figure A1.

As a check on this value, consider the estimates shown in Table A16, which were compiled by Baas (1999). Note that these estimates do not distinguish between inter-regional trade between New Zealand regions, intra-regional trade, and goods that are ultimately headed offshore or originally came from offshore.

[11] This the IO value of expenditure by households on domestic rail and water transport.

Table A16 New Zealand surface freight (million tonne-km).

Type	1995	1996	1997
Truck transport	12 690	13 134	13 810
All road transport	15 290	16 207	17 179*
Rail freight	3202	3260	3450
Coastal freight	7210	7238	7266*
Total	**25 702**	**26 705**	**27 895**

*estimate

Table A17 presents an estimated update of the road transport figures to the year ended March 2000/01.

Table A17 Tonne-kms: carried loads and maximum loads (million tonne-km).

Year	Carried[a]	Maximum (actual)[b]	Maximum (estimated)[c]
1995	15 290	–	42 496
1996	16 207	–	47 159
1997	17 179	–	51 116
1998[d]	*18 500*	–	53 365
1999	*18 600*	55 881	56 704
2000	*20 800*	59 118	59 448
2000/01	*21 000*	59 680	

Notes to Table A17:
a The 'Carried' 1995–1997 is taken directly from Table A16.
b The actual maximum tonne-km from RUC data
c This column shows estimated tonne-km based on actual RUC distance data by vehicle type multiplied by the average maximum load for each type in 1999, as implied by the data in the 'Maximum actual' column
d Actual maximum tonne-km data does not go back beyond 1999.

Assuming that the ratio of actual loads to maximum loads is unchanged from the 1997-99 average leads to the estimated carried loads for 1998 to 2000/01 (shown in *italics* in the 'Carried' column). Given the error margins involved, the estimate of 21 000 tonne-km for 2000/01 compares quite well with the 22 900 tonne-km calculated from IO data.

If rail and coastal shipping have managed to maintain their share of freight transport, about 11 300 million tonne-kms would have been transported by rail/water in 2000/01, implying that road's share is about 65%.[12] The Road Transport Forum[13] (2004) reports that in 2002, rail and coastal shipping accounted for about 9500 million tonne-km, suggesting that either the 2000/01 estimate is bit high or that these modes have lost market share.

[12] Incidentally, this implies a cost of $0.073 per tonne-km for rail/water transport. An interesting, albeit somewhat loose, check on this is that the road freight industry purchased $41 million of services from the rail/water industry. Table A13 shows that 569 million tonne-km moved between Wellington and Blenheim/Picton, implying a price of $0.072 per tonne-km.
[13] This report also estimates that heavy vehicles accounted for 19 450 million tonne-km in 2003.

Presumably, intra-regional freight is more likely to travel by road than rail or water, implying that the 65% is too high for the proportion of inter-regional trade going by road. However, the Cook Strait ferry link is implicitly part of road transport in our analysis. This accounts for about 7% of inter-regional trade in total tonne-km. Also, a large proportion of coastal shipping, perhaps up to 50%, is accounted for by oil products. Accordingly, out of the 8000 million tonne-km of inter-regional trade, probably about 5000 million tonne-km are likely to have travelled by road.

As noted earlier, the regional IO tables do not provide information that would help us to discover the inter-nodal routes where rail and water are likely to compete most effectively with road transport. While some options are clearly unlikely or even impossible, more specific industry information would be required to cross-classify inter-regional freight by route and mode.

A7 Estimating inter-regional freight flows from IO tables: an extension

A7.1 Introduction

In the course of a peer review of the earlier part of this Appendix (A), it emerged that it is possible to secure some additional information from the procedure used to generate regional IO tables. The information is the value of imports by type, imported by each region but not differentiated by region of origin except for a domestic–foreign split.

With this information, we can re-estimate inter-regional trade in two ways, either by replacing the previous export-based approach with an import based approach, or combining the two approaches and discarding the gravity model. These two approaches are discussed below, after section A7.2, which explains the new data.

A7.2 Data and equations

Equations A5–A7 state that the some of all imports into a given region equals imports/purchases from all other regions and from overseas. Equation A8 states that the sum of imports from overseas into all regions must be equal to total New Zealand imports.

The new information separates imports by type for all domestic regions of origin combined – the mix of domestic supplying regions is still unknown. Imports from offshore are known for each region, but not differentiated by commodity. In equation form:

$$\beta_i a + \gamma_i a = MD_i a \qquad \textit{Equation A20}$$

$$a_i \beta + \gamma_i \beta = MD_i \beta \qquad \textit{Equation A21}$$

$$a_i \gamma + \beta_i \gamma = MD_i \gamma \qquad \textit{Equation A22}$$

In Equations A20–A22, *MD* represents imports from all domestic sources combined – which is now known. Thus, Equations A20–A22 provide – for each commodity – the

column totals of an inter-regional trade matrix where the columns are domestic regional imports and the rows are domestic regional exports (se Figure A3).

Domestic inter-regional trade flows *(n x n)*	Exports over all regions *(n x 1)*
Imports over all regions *(1 x n)*	

Figure A3 Inter-regional trade schematic (for each commodity).

Now we know the individual values of $\Omega a, \Omega \beta, \Omega \gamma$ in Equation A8, but we have no *i* subscript. That is, we know imports from offshore into each region, but not the commodity composition of those imports.

In essence, the estimation of the trade matrix was originally undertaken on a row/export basis using the gravity model to determine the values in each cell, with Equations A1–A4 providing the row totals (as shown on the right of Figure A3).

With the addition of the new data, we now have two choices:

- Equations A20–A22 provide us with the means of estimating the matrix on a column/import basis instead of an export/row basis. The gravity model equations are still required to determine the pattern of inter-regional trade, as separating imports provides no additional information on the relative flows between domestic regions. In other words, the degrees of freedom in this regard are unchanged.
- An alternative is to take the bottom row showing exogenous regional import totals (i.e. imports into a given region from all other regions/overseas) (from the import-based method) and distribute them to regions of origin using the composition of exports derived from the exogenous right hand column of regional export totals (i.e. the total number of exports from a given region) (from the export-based method). This means that each cell of the regional trade matrix is determined without recourse to the gravity model.

A7.3 Results

A7.3.1 Import-based model plus gravity model method

While the degrees of freedom with regard to domestic inter-regional trade are unchanged, in one aspect of the methodology, the new data reduce the degrees of freedom. Under the export-based approach, we had to make an assumption on the proportion of exports from a given region (of a given type) that go offshore rather than to other domestic regions (see Equation A16). Because we now know the Ωn (foreign imports into region n), adapting Equation A16 is unnecessary.

In other respects, the methodology is the same as before. The value of trade flows is derived first, and this is converted into tonnes and finally into tonne-kms. Table A18 shows the original results and the new results, along with the percentage differences.

Table A18 Summary of the differences between the previous IO analysis and the new methodology.

Value	Original (export-based)	Alternative (import-based)	% difference
Value of inter-regional trade ($ million)	18 286	17 156	-6.3%
Weight of inter-regional trade (thousand tonnes)	17 907	17 098	-4.5%
Tonne-km of inter-regional trade (million)	7947	7495	-5.7%

The import-based estimates are slightly lower than the export-based ones. If the trade values were identical (as they should be), the import-based approach would show about 0.6% more tonne-kms than the export-based approach, and about 1.9% more weight.

Why are the values not identical? Butcher Partners, who undertook the peer review, explain that the methodology used to generate regional IO tables was originally devised to estimate industry economic multipliers. While the estimation of total final demand by industry and by local v. imported production is an important part of this estimation, the composition of final demand between three components (capital formation, stock change and exports) is of little consequence. On the basis of the additional import information, it now appears that regional exports are slightly too high when combined. Hence, the export-based estimates of inter-regional trade are also slightly too high.

Butcher Partners suggest, however, that the composition of exports from each region is likely to be reasonably reliable, even though each region's total exports may be too high (or too low). In other words, we can allow the proportions in the right hand column of Figure A3 to dictate the proportions for the whole table, making the gravity model equations redundant.

A7.3.2 Combined import/export-based method

In the export-based estimation, regional exports of each commodity are distributed across destination regions by applying the gravity model equations on a row-by-row basis, with the bottom row of regional import totals (in Figure A3) being endogenous (coming into the region from overseas or other regions). In the import-based model, regional imports of each commodity are distributed by region of origin, using the gravity model equations on a column-by-column basis, with the right hand column of regional export totals being endogenous.

As noted above, we now take the exogenous (from outside the region, whether from another region or from overseas) bottom row of regional import totals and distribute them to origin regions using the composition of exports. This means that each cell of the regional trade matrix is determined without using the gravity model. It also means, however, that distance is totally ignored in estimating inter-regional trade; an implausible scenario for goods trade.

As might be expected, this method generates a higher estimate for inter-regional trade: 11 383 million tonne-km, about 50% more than the 7,495 million tonne-km estimated with the gravity model (because the core data from the import-based approach still applies, the total value and weight of inter-regional trade does not change).

While we cannot claim that the gravity model cannot be improved, it is more plausible than assuming that distance has no affect on inter-regional trade.

A possible hybrid option would be to use the gravity model for estimating an initial mix of inter-regional trade, and then use an iterative RAS[14] type procedure to ensure that the row and column sums equate to the exogenous (i.e. originating outside the region) totals. While we are reasonably confident that the procedure would converge, whether the results would have economic meaning is not clear.

A7.4 Options for further analysis

A7.4.1 Introduction

Apart from the hybrid approach just outlined, two further extensions to the research would seem productive:

- sensitivity analysis with respect to a few key assumptions, and
- some further effort to cross-check the results.

A7.4.2 Sensitivity analysis

Four priorities for sensitivity analysis come to mind:

- **The cost of travel, approximated by time, in the denominator in the gravity model** (Equation A10) – e.g. with an exponent of ½ instead of 1. This method should simulate how the unit cost of travel for a given type of terrain, and assuming no change in mode, declines with distance. The complete removal of the gravity model described above is analogous to setting the exponent on the distance/time term to zero.
- **A higher (or lower) cost penalty on freight that crosses Cook Strait**.
- **A change in the economic mass arguments** that constitute the numerator in Equation A10. Currently, these are the gross output of the given exporting industry in the origin region and the gross output of all industries in the destination region, excluding the given industry. Some alternative specifications still capture the general concept of regions exporting goods from their largest industries and importing goods in relation to the size of the rest of their economy.
- **Industry gross output mean prices** – say ±20%.

A7.4.3 Extended analysis

Chapter A6 discusses the difficulty of establishing alternative and independent estimates of inter-regional freight movements. However, independent estimates of total freight movements exist. Could the analysis of IO data also produce such estimates?

[14] An iterative method for matrix balancing, known as RAS, was developed by Stone and other members of the Cambridge Growth Project.

From the regional IO data, we have estimated the value and weight of inter-regional trade flows and converted them into tonne-kms. In the process, we have also estimated the value of trade flows between regions and overseas; hence, the value of intra-regional trade flows is a residual.

Using industry gross output prices and estimated travel routes, it should be possible to obtain an estimate of tonne-kms of intra-regional freight, and of overseas exports and imports. Together with the tonne-kms of inter-regional freight, we would then have an IO-based estimate of total tonne-kms of freight transported throughout New Zealand. This could be compared with the independent estimates discussed in Chapter A6.

The main areas of uncertainty are:

- whether overseas exports and imports depart from or arrive at the nearest port;
- gross output prices; and
- mean distance travelled with regard to intra-regional trade.

The last of these is particularly tricky and seems to have a very wide error margin.

Appendix B: Spreadsheet IRTrade.xls

B1 Introduction

This section contains the tables given in the spreadsheet file IRtrade.xls that was used for the IO analysis. The spreadsheet consists of three linked worksheets: XGO, Trade and tkm.

B2 XGO

This worksheet contains gross output and exports in $/tonne for 17 industries for each of the 15 New Zealand regions, and for all regions combined in 2000/2001. This is used to provide the weights in the gravity equations.

Table B1 Gross outputs and exports for Northland in $/tonne.

Industry	Exports	Gross output
Horticulture	129 098	209 933
Pastoral agriculture	237 288	795 665
Forests	216 526	307 700
Fishing	88 161	113 415
Mining	82 090	100 863
Meat processing	160 084	216 623
Dairy processing	431 238	504 933
Other food, beverages and tobacco	38 305	91 088
Textiles	17 403	30 701
Wood products	102 650	177 232
Paper products	27 681	65 288
Petroleum	539 139	567 284
Chemicals	41 779	111 209
Non-metallic chemicals	52 041	91 271
Basic and fabricated materials	55 407	98 534
Equipment and machinery	117 849	218 355
Services	1 295 288	4 259 076
Total	**3 632 027**	**7 959 171**

Comment [MCF1]: What units? Dollars? Tonnes?

Table B2 Gross outputs and exports for Auckland in $/tonne.

Industry	Exports	Gross output
Horticulture	211 709	371 169
Pastoral agriculture	207 561	355 261
Forests	62 726	100 862
Fishing	117 094	146 964
Mining	75 251	147 291
Meat processing	119 975	453 094
Dairy processing	1 073 330	1 289 157
Other food, beverages and tobacco	1 422 366	2 876 282
Textiles	394 367	958 407
Wood products	143 547	514 430
Paper products	888 938	2 747 766
Petroleum	17 719	25 093
Chemicals	1 593 896	2 604 262
Non-metallic chemicals	177 547	682 868
Basic and fabricated materials	966 966	2 313 566
Equipment and machinery	1 398 265	3 588 239
Services	13 957 038	56 011 019
Total	**22 828 296**	**75 185 729**

Table B3 Gross outputs and exports for Waikato in $/tonne.

Industry	Exports	Gross output
Horticulture	102 942	333 622
Pastoral agriculture	1 080 045	2 828 030
Forests	364 393	700 219
Fishing	76 324	99 153
Mining	258 025	366 800
Meat processing	542 451	869 752
Dairy processing	1 476 170	1 660 757
Other food, beverages and tobacco	102 518	272 408
Textiles	33 668	102 571
Wood products	401 764	608 994
Paper products	338 881	598 696
Petroleum	0	3869
Chemicals	193 213	420 830
Non-metallic chemicals	38 288	149 905
Basic and fabricated materials	300 943	535 424
Equipment and machinery	384 040	785 343
Services	2 663 349	12 382 317
Total	**8 357 015**	**22 718 689**

Table B4 Gross outputs and exports for Bay of Plenty in $/tonne.

Industry	Exports	Gross output
Horticulture	438 297	547 328
Pastoral agriculture	153 583	613 883
Forests	127 361	394 002
Fishing	12 113	53 244
Mining	23 380	43 632
Meat processing	161 659	258 894
Dairy processing	356 201	479 686
Other food, beverages and tobacco	200 573	421 855
Textiles	21 930	58 642
Wood products	332 671	469 128
Paper products	786 218	991 424
Petroleum	10 159	13 196
Chemicals	149 934	296 902
Non-metallic chemicals	11 180	66 997
Basic and fabricated materials	51 123	160 429
Equipment and machinery	216 001	491 681
Services	1 905 358	8 104 313
Total	**4 957 741**	**13 491 236**

Table B5 Gross outputs and exports for Gisborne in $/tonne.

Industry	Exports	Gross output
Horticulture	130 589	170 800
Pastoral agriculture	168 689	223 688
Forests	151 154	179 332
Fishing	12 752	21 868
Mining	1049	4825
Meat processing	23 620	24 152
Dairy processing	4734	4734
Other food, beverages and tobacco	155 772	206 918
Textiles	16 510	20 309
Wood products	44 099	56 242
Paper products	11 174	31 423
Petroleum	0	0
Chemicals	3810	4896
Non-metallic chemicals	9215	16 517
Basic and fabricated materials	9869	21 314
Equipment and machinery	15 238	34 095
Services	413 350	1 333 174
Total	**1 171 623**	**2 354 286**

Table B6 Gross outputs and exports for Hawkes Bay in $/tonne.

Industry	Exports	Gross output
Horticulture	211 449	368 693
Pastoral agriculture	55 789	607 160
Forests	111 000	180 777
Fishing	13 073	22 955
Mining	31 051	41 010
Meat processing	742 526	924 773
Dairy processing	11 834	11 834
Other food, beverages and tobacco	693 042	891 640
Textiles	182 285	229 029
Wood products	48 367	83 554
Paper products	179 934	288 169
Petroleum	1914	1914
Chemicals	61 358	157 213
Non-metallic chemicals	21 882	67 247
Basic and fabricated materials	54 157	114 532
Equipment and machinery	113 098	235 413
Services	1 342 952	4 883 932
Total	**3 875 712**	**9 109 845**

Table B7 Gross outputs and exports for Taranaki in $/tonne.

Industry	Exports	Gross output
Horticulture	9258	71 937
Pastoral agriculture	54 199	1 046 619
Forests	10 911	24 509
Fishing	10 240	11 545
Mining	698	25 346
Meat processing	450 082	539 832
Dairy processing	1 098 745	1 164 502
Other food, beverages and tobacco	74 775	115 236
Textiles	16 474	26 985
Wood products	76816	115 438
Paper products	36 014	70 255
Petroleum	7750	7750
Chemicals	232 792	331 695
Non-metallic chemicals	9303	28 678
Basic and fabricated materials	246 526	312 773
Equipment and machinery	125 368	204 196
Services	2 669 055	5 130 983
Total	**5 129 004**	**9 228 280**

Table B8 Gross outputs and exports for Manawatu/Wanganui in $/tonne.

Industry	Exports	Gross output
Horticulture	128 747	271 874
Pastoral agriculture	496 073	1 299 066
Forests	61 928	163 298
Fishing	5491	7063
Mining	19 383	37 968
Meat processing	389 098	585 379
Dairy processing	374 815	433 138
Other food, beverages and tobacco	207 116	389 821
Textiles	214 977	323 778
Wood products	90 612	175 587
Paper products	143 263	288 513
Petroleum	38	821
Chemicals	174 984	262 655
Non-metallic chemicals	13 349	65 409
Basic and fabricated materials	92 199	193 169
Equipment and machinery	168 907	410 944
Services	1 795 912	7 758 774
Total	**4 376 890**	**12 667 256**

Table B9 Gross outputs and exports for Wellington in $/tonne.

Industry	Exports	Gross output
Horticulture	48 507	75 541
Pastoral agriculture	288 926	404 691
Forests	59 907	97 146
Fishing	31 518	41 019
Mining	29 150	45 835
Meat processing	159 166	307 390
Dairy processing	108 044	129 389
Other food, beverages and tobacco	202 790	428 656
Textiles	66 614	180 565
Wood products	106 070	217 413
Paper products	198 319	784 118
Petroleum	5332	10 546
Chemicals	504 482	754 435
Non-metallic chemicals	63 474	124 834
Basic and fabricated materials	198 712	406 289
Equipment and machinery	289 205	675 469
Services	5 499 842	22 848 638
Total	**7 860 058**	**27 531 975**

Table B10 Gross outputs and exports for Tasman/Nelson in $/tonne.

Industry	Exports	Gross output
Horticulture	136 749	185 038
Pastoral agriculture	84 842	208 572
Forests	92 485	174 855
Fishing	0	298 953
Mining	14 711	21 921
Meat processing	36 538	67 023
Dairy processing	85 521	123 077
Other food, beverages and tobacco	597 173	698 568
Textiles	15 010	28 421
Wood products	137 143	191 509
Paper products	24 364	60 563
Petroleum	2285	3337
Chemicals	25 590	48 924
Non-metallic chemicals	15 385	40 342
Basic and fabricated materials	39 617	68 830
Equipment and machinery	51 475	118 728
Services	881 152	3 026 047
Total	**2 240 039**	**5 364 708**

Table B11 Gross outputs and exports for Marlborough in $/tonne.

Industry	Exports	Gross output
Horticulture	57 201	104 744
Pastoral agriculture	30 090	169 889
Forests	57 150	81 839
Fishing	108 904	203 603
Mining	30 051	32 514
Meat processing	106 027	129 843
Dairy processing	68 995	84 418
Other food, beverages and tobacco	429 821	493 580
Textiles	6581	10 551
Wood products	21 361	43 706
Paper products	11 781	28 675
Petroleum	0	0
Chemicals	15 218	22 455
Non-metallic chemicals	3077	7896
Basic and fabricated materials	9628	26 971
Equipment and machinery	70 856	107 104
Services	542 889	1 453 007
Total	**1 569 632**	**3 000 795**

Table B12 Gross outputs and exports for Canterbury in $/tonne.

Industry	Exports	Gross output
Horticulture	260 429	546 891
Pastoral agriculture	179 667	1 424 198
Forests	66 800	135 254
Fishing	0	143 840
Mining	24 211	65 936
Meat processing	794 559	1 315 296
Dairy processing	778 630	952 272
Other food, beverages and tobacco	882 135	1 461 160
Textiles	434 875	717 341
Wood products	158 358	389 848
Paper products	283 361	802 475
Petroleum	15 293	22 409
Chemicals	428 865	875 093
Non-metallic chemicals	56 817	229 912
Basic and fabricated materials	189 087	572 463
Equipment and machinery	930 027	1 841 205
Services	4 266 058	20436 543
Total	**9 749 171**	**31 932 135**

Table B13 Gross outputs and exports for West Coast in $/tonne.

Industry	Exports	Gross output
Horticulture	1215	12 969
Pastoral agriculture	45 481	213 625
Forests	33 993	71 637
Fishing	8136	32 055
Mining	226 685	247 601
Meat processing	41 688	54 761
Dairy processing	176 443	190 928
Other food, beverages and tobacco	53 085	64 345
Textiles	1273	2788
Wood products	68 202	84 766
Paper products	11 144	17 402
Petroleum	60	549
Chemicals	5763	10 422
Non-metallic chemicals	36 254	51 285
Basic and fabricated materials	3525	5582
Equipment and machinery	28 495	37 690
Services	459 938	1 076 442
Total	**1 201380**	**2 174 847**

Table B14 Gross outputs and exports for Otago in $/tonne.

Industry	Exports	Gross output
Horticulture	27 546	134 950
Pastoral agriculture	106 502	898 883
Forests	30 798	142 322
Fishing	0	31 104
Mining	124 087	145 359
Meat processing	865 589	1 085 154
Dairy processing	333 928	388 956
Other food, beverages and tobacco	277 426	520 703
Textiles	133 540	196 187
Wood products	113 282	185 742
Paper products	95 931	236 862
Petroleum	3614	5182
Chemicals	35 152	130 158
Non-metallic chemicals	9386	51 468
Basic and fabricated materials	95 623	168 639
Equipment and machinery	186 331	366 247
Services	2 048 693	7 245 229
Total	**4 487 426**	**11 933 145**

Table B15 Gross outputs and exports for Southland in $/tonne.

Industry	Exports	Gross output
Horticulture	696	81 299
Pastoral agriculture	0	956 692
Forests	5153	68 008
Fishing	44 853	104 586
Mining	28 068	72 402
Meat processing	1 039 886	1 155 333
Dairy processing	381 512	439 450
Other food, beverages and tobacco	119 191	179 306
Textiles	50 837	64 734
Wood products	119 347	152438
Paper products	36 151	80 737
Petroleum	1185	1926
Chemicals	38 714	94 073
Non-metallic chemicals	11 939	41 657
Basic and fabricated materials	378 014	447 678
Equipment and machinery	57 827	116 465
Services	1 198 339	3 263 806
Total	**3 511 714**	**7 320 588**

Table B16 Gross outputs and exports from all New Zealand to overseas in $/tonne.

Industry	Exports	Gross output
Horticulture	1 303 930	3 486 790
Pastoral agriculture	377 560	12 055 440
Forests	848 280	2 823 570
Fishing	203 250	1 358 260
Mining	438 950	1 416 240
Meat processing	4 371 450	8 050 260
Dairy processing	5 475 110	7 889 580
Other food, beverages and tobacco	2 783 590	9 139 730
Textiles	969 840	2 952 090
Wood products	1 270 990	3 503 310
Paper products	1 565 890	7 066 660
Petroleum	48 960	652 440
Chemicals	2 057 640	6 108 740
Non-metallic chemicals	100 000	1 718 420
Basic and fabricated materials	1 493 790	5 440 260
Equipment and machinery	2 413 540	9 215 330
Services	14 207 670	158 948 399
Total	**39 930 440**	**241 825 519**

Table B17 Sum of exports from all regions throughout New Zealand in $/tonne.

Industry	**Exports**
Horticulture	1 894 431
Pastoral agriculture	3 188 735
Forests	1 452 285
Fishing	528 659
Mining	967 890
Meat processing	5 632 946
Dairy processing	6 760 142
Other food, beverages and tobacco	5 456 089
Textiles	1 606 343
Wood products	1 964 291
Paper products	3 073 153
Petroleum	604 488
Chemicals	3 505 547
Non-metallic chemicals	529 139
Basic and fabricated materials	2 691 396
Equipment and machinery	4 152 983
Services	40 939 212
Total	**84 947 729**
Total exports from all regions: To overseas To other regions	84 947 729 39 930 440 45 017 289
Total imports by regions: From overseas From other regions	78 937 587 0 78 937 587
Inconsistency	-33 920 298 -54.7%

The inconsistency is probably caused by incomplete import balancing in the 'final demand' quadrant of the IO tables. The export-based figures should be used.

B3 Trade

B3.1 Original layout of the worksheet

In its original form, this worksheet is the largest because of the need to deal with numerous industries and regions. It is composed of 6 blocks aligned approximately as follows:

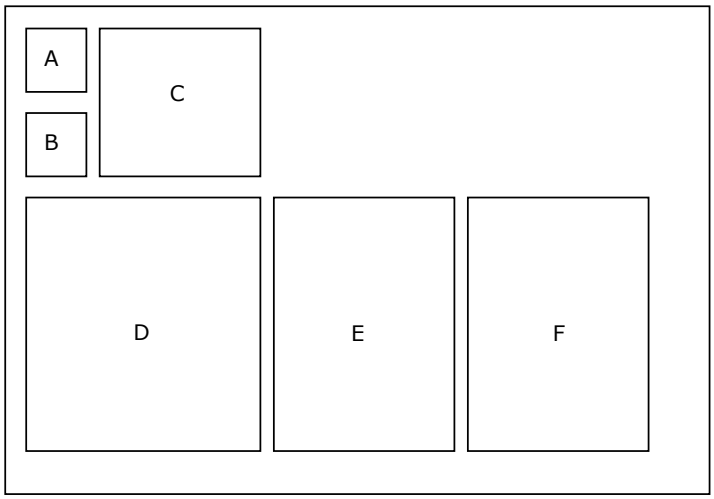

Figure B1 Schematic of 'Trade' worksheet in its original form.

- **A:** Average prices of gross output by industry in $/tonne. This relates to Chapter 4 in Appendix A).
- **B:** Regional gross output from XGO worksheet .
- **C:** Inter-regional travel times including allowance for Cook Strait and conversion of hours and minutes into decimal hours (Table B23). The results are the d_{pq} in Equation A10.
- **D:** Calculation of relative values of inter-regional trade using Equations A10, A12 and A13.
- **E:** Conversion of the relative values in block D into absolute dollar values.
- **F:** Conversion of trade flows in dollar values into trade flows in terms of weight (thousand tonnes), using the industry mean output prices from block A.

B3.2 Average prices

Table B18 Average unit prices of gross output by industry in $/tonne.

Industry	$/tonne
Horticulture	1,400
Pastoral agriculture	2,500
Forests	270
Fishing	5,630
Mining	70
Meat processing	5,020
Dairy processing	3,820
Other food, beverages and tobacco	1,850
Textiles	7,460
Wood products	2,740
Paper products	1,090
Petroleum	540
Chemicals	1,590
Non-metallic products	1,980
Basic and fabricated materials	2,310
Equipment and machinery	21,280

B3.3 Regional gross output

Table B19 Gross output of all New Zealand regions.

Region	$million
Northland	7 959 171
Auckland	75 185 729
Waikato	22 718 689
Bay of Plenty	13 491 236
Gisborne	2 354 286
Hawkes Bay	9 109 845
Taranaki	9 228 280
Manawatu/Wanganu	12 667 256
Wellington	27 531 975
Tasman/Nelson	5 364 708
Marlborough	3 000 795
Canterbury	31 932 135
West Coast	2 174 847
Otago	11 933 145
Southland	7 320 588
Total	241 972 685

B3.4 Inter-regional travel times

Throughout this section and subsequent sections, the following abbreviations have been used:

- N Northland
- A Auckland
- WK Waikato
- BP Bay of Plenty
- G Gisborne
- HB Hawkes Bay
- T Taranaki
- MW Manawatu/Wanganui
- WT Wellington
- TN Tasman/Nelson
- M Marlborough
- C Canterbury
- WC West Coast
- O Otago
- S Southland

Table B20 Inter-regional travel times within the North Island in hours and minutes.

Region	**Town**	**Destination**								
		N	A	WK	BP	G	HB	T	MW	WT
Northland	Whangarei	–	3:00	4:55	6:20	11:20	9:35	9:20	10:40	12:50
Auckland	Auckland		–	1:55	3:20	8:20	6:35	6:20	7:40	9:15
Waikato	Hamilton			–	1:55	6:30	4:40	4:25	5:45	7:30
Bay of Plenty	Tauranga				–	5:00	4:55	5:40	6:00	8:00
Gisborne	Gisborne					–	3:25	10:25	6:05	8:15
Hawkes Bay	Napier						–	6:15	2:40	4:50
Taranaki	New Plymouth							–	3:35	5:10
Manawatu/ Wanganui	Palmerston North								–	2:10
Wellington	Wellington									–

Table B21 Inter-regional travel time within the South Island in hours and minutes.

Region	Town	Destination					
		M	TN	C	WC	O	S
Marlborough	Blenheim	–	1:45	4:35	5:05	9:35	12:45
Tasman/Nelson	Nelson		–	6:15	4:35	11:05	14:15
Canterbury	Christchurch			–	4:10	5:00	8:10
West Coast	Greymouth				–	8:10	11:20
Otago	Dunedin					–	3:10
Southland	Invercargill						–

The time taken to cross Cook Strait from Wellington to Picton (and *vice versa*) is three and a half hours. This amount was taken into account for the times in Table B23.

The digital time to travel from regional centres within the South Island to the Picton ferry is shown in Table B22.

Table B22 Travel time between the Picton Ferry from South Island regional centres in hours and minutes.

Region	Town	Destination					
		M	**TN**	**C**	**WC**	**O**	**S**
Marlborough	Picton	0.25	2.10	5.00	5.50	10.00	13.17

Table B23 Inter-regional travel times within New Zealand in digital hours.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	W	TN	M	C	WC	O	S	Check
N	–	3.0	4.92	6.33	11.33	9.58	9.33	10.67	12.83	18.50	16.75	21.33	21.83	26.33	29.50	202.25
A		–	1.92	3.33	8.33	6.58	6.33	7.67	9.25	14.92	13.17	17.75	18.25	22.75	25.92	159.17
WK			–	1.92	6.50	4.67	4.42	5.75	7.50	13.17	11.42	16.00	16.50	21.00	24.17	139.83
BP				–	5.00	4.92	5.67	6.00	8.00	13.67	11.92	16.50	17.00	21.50	24.67	146.42
G					–	3.42	10.42	6.08	8.25	13.92	12.17	16.75	17.25	21.75	24.92	166.08
HB						–	6.25	2.67	4.83	10.50	8.75	13.33	13.83	18.33	21.50	129.17
T							–	3.58	5.17	10.83	9.08	13.67	14.17	18.67	21.83	139.42
MW								–	2.17	7.83	6.08	10.67	11.17	15.67	18.83	114.83
W									–	5.67	3.92	8.50	9.00	13.50	16.67	115.25
TN										–	1.75	6.25	4.58	11.08	14.25	149.08
M											–	4.58	5.08	9.58	12.75	127.42
C												–	4.17	5.00	8.17	167.67
WC													–	8.17	11.33	177.83
O														–	3.17	226.50
S															–	270.83

B3.5 Relative values of inter-regional trade

Table B24 Total gross output and output for all New Zealand regions across all industries.

Region	Total gross output ($billion)
Northland	7.959
Auckland	75.186
Waikato	22.719
Bay of Plenty	13.491
Gisborne	2.354
Hawkes Bay	9.110
Taranaki	9.228
Manawatu/Wanganu	12.667
Wellington	27.532
Tasman/Nelson	5.365
Marlborough	3.001
Canterbury	31.932
West Coast	2.175
Otago	11.933
Southland	7.321
Total	**241,973**

Table B25 Value of horticultural output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	129,098	209,933	0.210
Auckland	211,709	371,169	0.371
Waikato	102,942	333,622	0.334
Bay of Plenty	438,297	547,328	0.547
Gisborne	130,589	170,800	0.171
Hawkes Bay	211,449	368,693	0.369
Taranaki	9,258	71,937	0.072
Manawatu/Wanganui	128,747	27,874	0.272
Wellington	48,507	75,541	0.076
Tasman/Nelson	136,749	185,038	0.185
Marlborough	57,201	104,744	0.105
Canterbury	260,429	546,891	0.547
West Coast	1,215	12,969	0.013
Otago	27,564	134,950	0.135
Southland	696	81,299	0.081

Table B26 Gravity-based relative estimates for inter-regional horticultural trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	5.235	0.956	0.429	0.040	0.191	0.206	0.244	0.449	0.059	0.036	0.309	0.021	0.094	0.052	8.321
A	0.959	–	4.335	1.441	0.097	0.493	0.537	0.600	1.102	0.129	0.082	0.656	0.044	0.192	0.104	10.771
WK	0.526	13.022	–	2.253	0.112	0.625	0.692	0.719	1.221	0.131	0.085	0.654	0.044	0.187	0.100	20.372
BP	0.670	12.284	6.392	–	0.239	0.973	0.884	1.131	1.878	0.207	0.133	1.041	0.070	0.300	0.161	26.364
G	0.117	1.533	0.588	0.442	–	0.437	0.150	0.348	0.568	0.064	0.041	0.320	0.021	0.093	0.050	4.772
HB	0.298	4.190	1.769	0.971	0.236	–	0.540	1.714	2.094	0.182	0.122	0.868	0.058	0.237	0.124	13.402
T	0.060	0.850	0.365	0.164	0.015	0.101	–	0.249	0.382	0.034	0.023	0.165	0.011	0.045	0.024	2.488
MW	0.198	2.653	1.058	0.587	0.098	0.891	0.695	–	3.445	0.180	0.129	0.800	0.053	0.205	0.105	11.095
WT	0.046	0.611	0.225	0.122	0.020	0.137	0.134	0.432	_	0.069	0.056	0.279	0.018	0.066	0.033	2.248
TN	0.078	0.928	0.315	0.175	0.029	0.154	0.156	0.293	0.897	–	0.306	0.929	0.087	0.197	0.094	4.638
M	0.048	0.595	0.205	0.114	0.019	0.105	0.106	0.213	0.734	0.310	–	0.717	0.045	0.129	0.059	3.400
C	0.199	2.305	0.765	0.429	0.071	0.359	0.366	0.636	1.767	0.453	0.346	–	0.284	1.290	0.485	9.754
WC	0.005	0.053	0.018	0.010	0.002	0.008	0.008	0.014	0.040	0.015	0.007	0.098	–	0.019	0.008	0.304
O	0.040	0.444	0.144	0.081	0.014	0.064	0.066	0.107	0.274	0.063	0.041	0.847	0.036	–	0.309	2.529
S	0.021	0.235	0.075	0.043	0.007	0.033	0.034	0.054	0.134	0.030	0.018	0.312	0.016	0.303	–	1.315
Total																121.77

Table B27 Value of pastoral agricultural output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	237,288	795,665	0.796
Auckland	207,561	355,261	0.355
Waikato	1,080,045	2,828,030	2.828
Bay of Plenty	153,583	613,883	0.614
Gisborne	168,689	223,688	0.224
Hawkes Bay	55,789	607,160	0.607
Taranaki	54,199	1, 046,619	1.047
Manawatu/Wanganui	496,073	1,299,066	1.299
Wellington	288,926	404,691	0.405
Tasman/Nelson	84,842	208,572	0.209
Marlborough	30,090	169,889	0.170
Canterbury	179,667	1,424,198	1.42
West Coast	45,481	213,625	0.214
Otago	106,502	898,883	0.899
Southland	0	956,692	0.957

Table B28 Gravity-based relative estimates for inter-regional pastoral agricultural trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	19.847	3.219	1.618	0.150	0.706	0.697	0.848	1.682	0.222	0.134	1.138	0.071	0.333	0.172	30.837
A	0.848	–	3.687	1.372	0.091	0.459	0.459	0.527	1.042	0.123	0.076	0.611	0.038	0.172	0.087	9.592
WK	4.120	110.412	–	19.000	0.927	5.153	5.239	5.591	10.229	1.107	0.701	5.392	0.336	01.486	0.745	170.439
BP	0.694	13.781	6.371	–	0.262	1.062	0.886	1.163	2.082	0.232	0.146	1.135	0.071	0.315	0.158	28.357
G	0.141	2.009	0.685	0.576	–	0.557	0.176	0.418	0.736	0.083	0.052	0.407	0.025	0.113	0.057	6.035
HB	0.454	6.901	2.588	1.590	0.379	–	0.795	2.588	3.408	0.298	0.196	1.389	0.086	0.365	0.180	21.218
T	0.803	12.366	4.713	2.378	0.214	1.424	–	3.320	5.495	0.498	0.326	2.336	0.145	0.619	0.305	34.944
MW	0.872	12.680	4.494	2.788	0.455	4.142	2.966	–	16.265	0.855	0.605	3.715	0.228	0.915	0.439	51.419
WT	0.226	3.274	1.073	0.651	0.105	0.712	0.641	2.123	_	0.368	0.293	1.453	0.088	0.331	0.155	11.492
TN	0.081	1.046	0.315	0.197	0.032	0.169	0.158	0.303	0.998	–	0.337	1.018	0.089	0.208	0.093	5.044
M	0.073	0.966	0.296	0.184	0.030	0.165	0.153	0.317	1.177	0.501	–	1.131	0.066	0.196	0.085	5.337
C	0.478	6.004	1.771	1.112	0.181	0.908	0.853	1.518	4.545	1.175	0.880	–	0.670	3.143	1.110	24.347
WC	0.070	0.876	0.258	0.162	0.026	0.131	0.123	0.217	0.644	0.240	0.119	1.564	–	0.289	0.120	4.840
O	0.245	2.957	0.851	0.538	0.088	0.417	0.394	0.652	1.806	0.418	0.266	5.485	0.216	–	1.806	16.139
S	0.232	2.762	0.787	0.499	0.082	0.378	0.359	0.577	1.557	0.346	0.212	3.574	0.166	3.334	–	14.866
Total																434.91

Table B29 Value of forestry output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	216,526	307,700	0.308
Auckland	62,726	100,862	0.101
Waikato	364,393	700,219	0.700
Bay of Plenty	127,361	394,002	0.394
Gisborne	151,154	179,332	0.179
Hawkes Bay	111,000	180,777	0.181
Taranaki	10,911	24,509	0.025
Manawatu/Wanganui	61,928	163,298	0.163
Wellington	59,907	97,146	0.097
Tasman/Nelson	92,485	174,855	0.175
Marlborough	57,150	81,839	0.082
Canterbury	66,800	135,254	0.135
West Coast	33,993	71,637	0.072
Otago	30,798	142,322	0.142
Southland	5,153	68,008	0.068

Table B30 Gravity-based relative estimates for inter-regional forestry trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	7.701	1.378	0.636	0.059	0.287	0.303	0.361	0.658	0.086	0.054	0.459	0.030	0.138	0.076	12.225
A	0.257	–	1.159	0.396	0.026	0.137	0.147	0.165	0.299	0.035	0.022	0.181	0.012	0.052	0.028	2.916
WK	1.090	27.431	–	4.785	0.234	1.340	1.459	1.523	2.561	0.276	0.179	1.392	0.089	0.393	0.210	42.962
BP	0.476	8.875	4.526	–	0.171	0.716	0.640	0.821	1.351	0.150	0.097	0.759	0.049	0.216	0.116	18.963
G	0.121	1.616	0.607	0.470	–	0.469	0.158	0.369	0.596	0.067	0.043	0.340	0.022	0.097	0.052	5.028
HB	0.144	2.062	0.853	0.482	0.115	–	0.266	0.848	1.026	0.089	0.060	0.431	0.027	0.116	0.061	6.581
T	0.020	0.291	0.122	0.057	0.005	0.035	–	0.086	0.130	0.012	0.008	0.057	0.004	0.015	0.008	0.849
MW	0.117	1.599	0.625	0.356	0.058	0.547	0.419	–	2.068	0.108	0.078	0.487	0.031	0.123	0.063	6.680
WT	0.058	0.789	0.285	0.159	0.026	0.179	0.173	0.561	_	0.089	0.072	0.363	0.023	0.085	0.042	2.904
TN	0.072	0.880	0.292	0.168	0.027	0.149	0.149	0.279	0.847	–	0.292	0.890	0.080	0.186	0.089	4.399
M	0.037	0.467	0.158	0.090	0.015	0.084	0.083	0.168	0.573	0.243	–	0.568	0.034	0.101	0.047	2.666
C	0.049	0.572	0.186	0.107	0.018	0.091	0.091	0.159	0.437	0.112	0.086	–	0.068	0.319	0.120	2.414
WC	0.025	0.295	0.096	0.055	0.009	0.046	0.047	0.080	0.218	0.081	0.041	0.547	–	0.103	0.046	1.689
O	0.041	0.470	0.149	0.087	0.014	0.069	0.070	0.114	0.289	0.067	0.043	0.905	0.037	–	0.326	2.681
S	0.018	0.197	0.062	0.036	0.006	0.028	0.029	0.045	0.112	0.025	0.016	0.265	0.013	0.253	–	1.104
Total																114.06

Table B31 Value of fishing output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	88,161	113,415	0.113
Auckland	117,094	146,964	0.147
Waikato	76,324	99,153	0.099
Bay of Plenty	12,113	53,244	0.053
Gisborne	12,752	21,868	0.022
Hawkes Bay	13,073	22,955	0.023
Taranaki	10,240	11,545	0.012
Manawatu/Wanganui	5,491	7,063	0.007
Wellington	31,518	41,019	0.041
Tasman/Nelson	0	298,953	0.299
Marlborough	108,904	203,603	0.204
Canterbury	0	143,840	0.144
West Coast	8136	32,055	0.032
Otago	0	31,104	0.031
Southland	44,853	104,586	0.105

Table B32 Gravity-based relative estimates for inter-regional fishing trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	2.837	0.522	0.241	0.023	0.108	0.112	0.135	0.243	0.031	0.019	0.169	0.011	0.051	0.028	4..529
A	0.384	–	1.734	0.592	0.041	0.203	0.214	0.243	0.437	0.050	0.031	0.263	0.017	0.077	0.041	4.328
WK	0.158	3.882	–	0.695	0.036	0.193	0.207	0.218	0.363	0.038	0.024	0.197	0.013	0.056	0.030	6.111
BP	0.066	1.199	0.628	–	0.025	0.098	0.087	0.112	0.183	0.020	0.012	0.103	0.007	0.029	0.016	2.585
G	0.015	0.197	0.076	0.059	–	0.058	0.019	0.046	0.073	0.008	0.005	0.042	0.003	0.012	0.006	0.618
HB	0.019	0.262	0.111	0.063	0.016	–	0.034	0.109	0.131	0.011	0.007	0.055	0.004	0.015	0.008	0.843
T	0.010	0.137	0.059	0.027	0.003	0.017	–	0.041	0.061	0.005	0.004	0.027	0.002	0.007	0.004	0.403
MW	0.005	0.069	0.028	0.016	0.003	0.024	0.018	–	0.090	0.005	0.003	0.021	0.001	0.005	0.003	0.291
WT	0.025	0.333	0.124	0.069	0.012	0.077	0.073	0.240	_	0.037	0.029	0.153	0.010	0.036	0.018	1.235
TN	0.127	1.504	0.514	0.294	0.050	0.259	0.254	0.483	1.450	–	0.487	1.521	0.140	0.321	0.151	7.545
M	0.095	1.160	0.403	0.230	0.039	0.211	0.207	0.424	1.429	0.589	–	1.412	0.086	0.253	0.115	6.654
C	0.053	0.608	0.203	0.117	0.020	0.098	0.097	0.171	0.465	0.117	0.088	–	0.074	0.342	0.127	2.580
WC	0.012	0.132	0.044	0.025	0.004	0.021	0.021	0.036	0.098	0.035	0.018	0.245	–	0.047	0.020	0.758
O	0.009	0.103	0.034	0.019	0.003	0.015	0.015	0.025	0.063	0.014	0.009	0.198	0.008	–	0.071	0.587
S	0.028	0.303	0.098	0.057	0.010	0.044	0.044	0.070	0.173	0.037	0.023	0.407	0.020	0.393	–	1.707
Total																40.77

Table B33 Value of mining output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	82,090	100,863	0.101
Auckland	75,251	147,291	0.147
Waikato	258,025	366,800	0.367
Bay of Plenty	23,380	43,632	0.044
Gisborne	1,049	4,825	0.005
Hawkes Bay	31,051	41,010	0.041
Taranaki	698	25,346	0.025
Manawatu/Wanganui	19,383	37,968	0.038
Wellington	29,150	45,835	0.046
Tasman/Nelson	14,711	21,921	0.022
Marlborough	30,051	32,514	0.033
Canterbury	24,211	65,936	0.066
West Coast	226,685	247,601	0.248
Otago	124,087	145,359	0.145
Southland	28,068	72,402	0.072

Table B34 Gravity-based relative estimates for inter-regional mining trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	2.523	0.459	0.214	0.021	0.095	0.099	0.119	0.216	0.029	0.018	0.151	0.009	0.045	0.025	4.023
A	0.386	–	1.718	0.594	0.042	0.203	0.214	0.243	0.438	0.053	0.033	0.264	0.016	0.076	0.041	4.320
WK	0.586	14.360	–	2.574	0.133	0.713	0.764	0.806	1.344	0.149	0.095	0.731	0.043	0.206	0.110	22.613
BP	0.054	0.982	0.509	–	0.021	0.080	0.071	0.092	0.150	0.017	0.011	0.084	0.005	0.024	0.013	2.113
G	0.003	0.043	0.017	0.013	–	0.013	0.004	0.010	0.016	0.002	0.001	0.009	0.001	0.003	0.001	0.136
HB	0.034	0.467	0.196	0.112	0.028	–	0.060	0.194	0.233	0.021	0.014	0.098	0.006	0.026	0.014	1.504
T	0.021	0.300	0.128	0.060	0.006	0.037	–	0.089	0.135	0.013	0.008	0.059	0.003	0.016	0.008	0.884
MW	0.028	0.372	0.148	0.085	0.015	0.129	0.098	–	0.482	0.026	0.019	0.113	0.007	0.029	0.015	1.563
WT	0.028	0.372	0.137	0.077	0.013	0.086	0.082	0.267	_	0.043	0.035	0.172	0.010	0.040	0.020	1.381
TN	0.009	0.110	0.037	0.022	0.004	0.019	0.019	0.035	0.106	–	0.037	0.112	0.009	0.023	0.011	0.554
M	0.015	0.185	0.064	0.037	0.006	0.034	0.033	0.068	0.228	0.099	–	0.226	0.012	0.040	0.018	1.066
C	0.024	0.279	0.092	0.054	0.009	0.045	0.044	0.078	0.213	0.056	0.043	–	0.030	0.155	0.059	1.182
WC	0.089	1.018	0.335	0.196	0.034	0.162	0.161	0.280	0.756	0.289	0.145	1.894	–	0.357	0.158	5.874
O	0.043	0.479	0.155	0.091	0.016	0.072	0.072	0.117	0.296	0.070	0.045	0.926	0.034	–	0.333	2.749
S	0.019	0.210	0.067	0.039	0.007	0.031	0.031	0.049	0.119	0.027	0.017	0.283	0.012	0.270	–	1.180
Total																51.14

Table B35 Value of meat processing output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	160,084	216,623	0.217
Auckland	119,975	453,094	0.453
Waikato	542,451	869,752	0.870
Bay of Plenty	161,659	258,894	0.259
Gisborne	23,620	24,152	0.024
Hawkes Bay	742,526	924,773	0.925
Taranaki	450,082	539,832	0.540
Manawatu/Wanganui	389,098	585,379	0.585
Wellington	159,166	307,390	0.307
Tasman/Nelson	36,538	67,023	0.067
Marlborough	106,027	129,843	0.130
Canterbury	794,559	1,315,296	1.315
West Coast	41,688	54,761	0.055
Otago	865,589	1,085,154	1.085
Southland	1,039,886	1,155,333	1.155

Table B36 Gravity-based relative estimates for inter-regional meat processing trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	5.396	0.963	0.453	0.045	0.185	0.202	0.245	0.460	0.062	0.037	0.311	0.021	0.089	0.045	8.513
A	1.169	–	5.165	1.799	0.127	0.563	0.622	0.714	1.334	0.161	0.099	0.782	0.053	0.216	0.108	12.910
WK	1.370	33.912	–	6.005	0.312	1.525	1.711	1.828	3.157	0.350	0.219	1.664	0.112	0.449	0.222	52.836
BP	0.316	5.804	2.951	–	0.121	0.431	0.397	0.521	0.881	0.100	0.062	0.480	0.032	0.131	0.065	12.294
G	0.017	0.217	0.081	0.064	–	0.058	0.020	0.048	0.080	0.009	0.006	0.044	0.003	0.012	0.006	0.664
HB	0.747	10.498	4.330	2.489	0.631	–	1.286	4.190	5.209	0.467	0.303	2.124	0.142	0.547	0.265	33.226
T	0.448	6.370	2.671	1.261	0.121	0.707	–	1.820	2.845	0.264	0.171	1.209	0.081	0.314	0.152	18.432
MW	0.425	5.706	2.224	1.291	0.224	1.797	1.419	–	7.355	0.396	0.276	1.680	0.111	0.405	0.192	23.503
WT	0.185	2.483	0.895	0.508	0.087	0.521	0.517	1.714	_	0.287	0.225	1.107	0.072	0.247	0.114	8.964
TN	0.028	0.336	0.111	0.065	0.011	0.052	0.054	0.103	0.322	–	0.110	0.328	0.031	0.066	0.029	1.646
M	0.060	0.737	0.248	0.144	0.025	0.121	0.124	0.258	0.903	0.393	–	0.867	0.054	0.147	0.063	4.145
C	0.477	5.538	1.796	1.055	0.183	0.807	0.836	1.490	4.213	1.115	0.824	–	0.669	2.854	0.993	22.850
WC	0.019	0.224	0.073	0.043	0.007	0.032	0.034	0.059	0.166	0.063	0.031	0.402	–	0.073	0.030	1.256
O	0.319	3.565	1.129	0.668	0.116	0.484	0.505	0.837	2.188	0.519	0.325	6.645	0.282	–	2.113	19.695
S	0.303	3.331	1.045	0.620	0.108	0.440	0.460	0.741	1.887	0.430	0.260	4.331	0.216	3.958	–	18.130
Total																239.06

Table B37 Value of dairy processing output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	431,238	504,933	0.505
Auckland	1,073,330	1,289,157	1.289
Waikato	1,476,170	1,660,757	1.661
Bay of Plenty	356,201	479,686,4,764	0.480
Gisborne	4,734	4,734	0.005
Hawkes Bay	11,834	11,834	0.012
Taranaki	1,098,745	1,164,502	1.165
Manawatu/Wanganui	374,815	433,138	0.433
Wellington	108,044	129,389	0.129
Tasman/Nelson	85,521	123,077	0.123
Marlborough	68,995	84,418	0.084
Canterbury	778,630	952,272	0.952
West Coast	176,443	190,928	0.191
Otago	333,928	388,956	0.389
Southland	381,512	439,450	0.439

Table B38 Gravity-based relative estimates for inter-regional dairy processing trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	12.438	2.163	1.037	0.105	0.479	0.436	0.579	1.078	0.143	0.088	0.733	0.046	0.221	0.118	19.664
A	3.203	–	14.164	5.032	0.363	1.782	1.641	2.057	3.819	0.453	0.286	2.250	0.140	0.654	0.342	36.187
WK	2.518	64.030	–	11.274	0.600	3.238	3.032	3.534	6.068	0.661	0.424	3.216	0.200	0.913	0.473	100.180
BP	0.565	10.634	5.270	–	0.225	0.888	0.683	0.978	1.643	0.184	0.117	0.901	0.056	0.258	0.134	22.535
G	0.003	0.042	0.015	0.012	–	0.013	0.004	0.010	0.016	0.002	0.001	0.009	0.001	0.003	0.001	0.130
HB	0.009	0.133	0.053	0.031	0.008	–	0.015	0.054	0.067	0.006	0.004	0.027	0.002	0.007	0.004	0.422
T	0.930	13.587	5.552	2.674	0.263	1.695	–	3.976	6.176	0.563	0.374	2.640	0.163	0.720	0.367	39.680
MW	0.303	4.175	1.586	0.939	0.167	1.478	0.975	–	5.478	0.290	0.208	1.258	0.077	0.319	0.158	17.411
WT	0.075	1.034	0.363	0.210	0.037	0.244	0.202	0.731	_	0.120	0.096	0.472	0.029	0.111	0.053	3.776
TN	0.050	0.610	0.197	0.117	0.021	0.107	0.092	0.192	0.595	–	0.205	0.610	0.053	0.128	0.059	3.036
M	0.038	0.474	0.156	0.092	0.016	0.088	0.075	0.170	0.591	0.253	–	0.571	0.033	0.102	0.046	2.702
C	0.333	3.964	1.253	0.751	0.134	0.650	0.562	1.092	3.070	0.799	0.606	–	0.453	2.199	0.802	16.668
WC	0.065	0.773	0.244	0.146	0.026	0.126	0.109	0.209	0.581	0.218	0.110	1.420	–	0.270	0.116	4.412
O	0.110	1.263	0.390	0.235	0.042	0.193	0.168	0.304	0.790	0.184	0.118	2.410	0.094	–	0.845	7.147
S	0.111	1.253	0.383	0.232	0.041	0.186	0.162	0.285	0.723	0.162	0.101	1.667	0.077	1.602	–	6.985
Total																280.94

Table B39 Value of other food, beverages and tobacco output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	38,305	91,088	0.091
Auckland	1,422,366	2,876,282	2.876
Waikato	102,518	272,408	0.272
Bay of Plenty	200,573	421,855	0.422
Gisborne	155,772	206,918	0.207
Hawkes Bay	693,042	891,640	0.892
Taranaki	74,775	115,236	0.115
Manawatu/Wanganui	207,116	389,821	0.390
Wellington	202,790	428,656	0.429
Tasman/Nelson	597,173	698,568	0.699
Marlborough	429,821	493,580	0.494
Canterbury	882,135	1,461,160	1.461
West Coast	53,085	64,345	0.064
Otago	277,426	520,703	0.521
Southland	119,191	179,306	0.179

Table B40 Gravity-based relative estimates for inter-regional other food, beverage and tobacco trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	2.196	0.416	0.188	0.017	0.078	0.089	0.105	0.192	0.023	0.014	0.130	0.009	0.039	0.022	3.518
A	7.544	–	33.684	11.277	0.741	3.591	4.139	4.606	8.428	0.900	0.548	4.938	0.333	1.443	0.793	82.963
WK	0.436	10.277	–	1.857	0.090	0.480	0.562	0.582	0.984	0.097	0.060	0.519	0.035	0.148	0.080	16.207
BP	0.524	9.151	4.940	–	0.181	0.705	0.678	0.863	1.429	0.144	0.089	0.779	0.052	0.224	0.122	19.883
G	0.144	1.795	0.715	0.541	–	0.498	0.181	0.418	0.680	0.069	0.043	0.376	0.025	0.109	0.059	5.652
HB	0.732	9.794	4.289	2.370	0.560	–	1.300	4.105	5.000	0.396	0.255	2.038	0.136	0.555	0.296	31.827
T	0.097	1.316	0.586	0.266	0.024	0.152	–	0.395	0.605	0.050	0.032	0.257	0.017	0.070	0.038	3.903
MW	0.288	3.677	1.522	0.849	0.138	1.201	0.991	–	4.876	0.232	0.161	1.114	0.074	0.284	0.148	15.554
WT	0.263	3.351	1.283	0.700	0.112	0.729	0.756	2.429	_	0.353	0.274	1.537	0.101	0.362	0.184	12.433
TN	0.297	3.386	1.191	0.668	0.108	0.547	0.588	1.095	3.341	–	1.001	3.406	0.322	0.719	0.350	17.018
M	0.232	2.711	0.970	0.541	0.087	0.464	0.495	0.996	3.4116	1.316	–	3.281	0.205	0.588	0.276	15.579
C	0.539	5.952	2.050	1.157	0.187	0.901	0.974	1.682	4.659	1.091	0.799	–	0.740	3.335	1.278	25.345
WC	0.023	0.255	0.088	0.049	0.008	0.038	0.041	0.071	0.194	0.066	0.032	0.471	–	0.090	0.041	1.466
O	0.156	1.655	0.557	0.317	0.051	0.233	0.254	0.408	1.045	0.219	0.136	3.173	0.135	–	1.174	9.514
S	0.048	0.500	0.167	0.095	0.015	0.069	0.075	0.117	0.292	0.059	0.035	0.669	0.033	0.646	–	2.820
Total																263.68

Table B41 Value of textile output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	17,403	30,701	0.031
Auckland	394,367	958,407	0.958
Waikato	33,668	102,571	0.103
Bay of Plenty	21,930	58,642	0.059
Gisborne	16,510	20,309	0.020
Hawkes Bay	182,285	229,029	0.229
Taranaki	16,474	26,985	0.027
Manawatu/Wanganui	214,977	323,778	0.324
Wellington	6,6614	180,565	0.181
Tasman/Nelson	15,010	28,421	0.028
Marlborough	6,581	10,551	0.011
Canterbury	434,875	717,341	0.717
West Coast	1,273	2,788	0.003
Otago	133,540	196,187	0.196
Southland	50,837	64,734	0.065

Table B42 Gravity-based relative estimates for inter-regional textile trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	0.760	0.141	0.065	0.006	0.028	0.030	0.036	0.065	0.009	0.005	0.045	0.003	0.014	0.008	1.215
A	2.533	–	11.309	3.862	0.268	1.293	1.392	1.543	2.834	0.343	0.218	1.685	0.114	0.494	0.268	28.157
WK	0.165	3.972	–	0.719	0.037	0.915	0.214	0.220	0.374	0.042	0.027	0.200	0.014	0.057	0.031	6.267
BP	0.073	1.306	0.692	–	0.027	0.106	0.095	0.121	0.200	0.023	0.015	0.111	0.007	0.032	0.017	2.826
G	0.014	0.181	0.071	0.055	–	0.053	0.018	0.041	0.067	0.008	0.005	0.038	0.003	0.011	0.006	0.570
HB	0.189	2.582	1.110	0.626	0.156	–	0.337	1.060	1.296	0.116	0.078	0.536	0.036	0.147	0.077	8.348
T	0.023	0.316	0.138	0.064	0.006	0.038	–	0.093	0.143	0.013	0.009	0.062	0.004	0.017	0.009	0.935
MW	0.241	3.135	1.273	0.725	0.124	1.078	0.831	–	4.087	0.221	0.159	0.947	0.063	0.243	0.125	13.252
WT	0.112	1.449	0.544	0.303	0.051	0.332	0.322	1.029	_	0.170	1.138	0.663	0.044	0.157	0.079	5.391
TN	0.012	0.141	0.049	0.028	0.005	0.024	0.024	0.045	0.137	–	0.049	0.142	0.013	0.030	0.014	0.714
M	0.005	0.059	0.021	0.012	0.002	0.011	0.011	0.021	0.074	0.032	–	0.072	0.005	0.013	0.006	0.343
C	0.267	3.000	1.014	0.584	0.100	0.478	0.483	0.830	2.308	0.612	0.468	–	0.374	1.684	0.637	12.839
WC	0.001	0.011	0.004	0.002	0.000	0.002	0.002	0.003	0.008	0.003	0.002	0.021	–	0.004	0.002	0.065
O	0.059	0.640	0.211	0.123	0.021	0.095	0.097	0.155	0.397	0.094	0.061	1.225	0.052	–	0.450	3.680
S	0.017	0.185	0.061	0.035	0.006	0.027	0.027	0.042	0.106	0.024	0.015	0.247	0.012	0.240	–	1.047
Total																85.65

Table B43 Value of wood products output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	102,650	177,232	0.177
Auckland	143,547	514,430	0.514
Waikato	401,764	608,994	0.609
Bay of Plenty	332,671	495,128	0.495
Gisborne	44,099	56,242	0.056
Hawkes Bay	48,367	83,554	0.084
Taranaki	76,816	115,438	0.115
Manawatu/Wanganui	90,612	175,587	0.176
Wellington	106,070	217,413	0.217
Tasman/Nelson	137,143	191,509	0.192
Marlborough	21,361	43,706	0.044
Canterbury	158,358	389,848	0.390
West Coast	68,202	84,766	0.085
Otago	113,282	185,742	0.186
Southland	119,347	152,438	0.152

Table B44 Gravity-based relative estimates for inter-regional wood products trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	4.411	0.797	0.364	0.036	0.167	0.173	0.208	0.377	0.050	0.031	0.262	0.017	0.079	0.043	7.015
A	1.334	–	5.934	2.006	0.142	0.705	0.740	0.838	1.519	0.178	0.116	0.914	0.059	0.266	0.142	14.894
WK	0.964	23.726	–	4.129	0.215	1.178	1.257	1.323	2.218	0.239	0.158	1.201	0.077	0.341	0.181	37.206
BP	0.608	11.092	5.712	–	0.228	0.909	0.796	1.031	1.691	0.187	0.123	0.947	0.061	0.271	0.144	23.798
G	0.039	0.504	0.191	0.146	–	0.149	0.049	0.115	0.186	0.021	0.014	0.106	0.007	0.030	0.016	1.573
HB	0.068	0.948	0.396	0.221	0.056	–	0.122	0.391	0.472	0.041	0.028	0.198	0.013	0.054	0.028	3.035
T	0.096	1.361	0.578	0.265	0.025	0.167	–	0.402	0.610	0.055	0.038	0.266	0.017	0.073	0.038	3.992
MW	0.128	1.710	0.675	0.380	0.066	0.594	0.447	–	2.214	0.116	0.085	0.519	0.033	0.132	0.067	7.166
WT	0.132	1.755	0.641	0.353	0.061	0.406	0.383	1.253	_	0.198	0.164	0.807	0.050	0.189	0.094	6.487
TN	0.081	0.959	0.322	0.182	0.032	0.165	0.161	0.305	0.923	–	0.324	0.967	0.087	0.203	0.096	4.806
M	0.020	0.248	0.085	0.048	0.008	0.045	0.044	0.090	0.305	0.129	–	0.301	0.018	0.054	0.025	1.418
C	0.142	1.640	0.539	0.307	0.053	0.264	0.260	0.457	1.253	0.323	0.252	–	0.196	0.916	0.342	6.943
WC	0.030	0.347	0.114	0.065	0.011	0.055	0.055	0.095	0.257	0.096	0.049	0.642	–	0.122	0.054	1.991
O	0.055	0.610	0.196	0.112	0.020	0.091	0.091	0.148	0.376	0.087	0.057	1.172	0.048	–	0.420	3.482
S	0.040	0.439	0.139	0.080	0.014	0.064	0.064	0.101	0.250	0.055	0.035	0.589	0.028	0.566	–	2.465
Total																126.27

Table B45 Value of paper products output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	27,681	65,288	0.065
Auckland	888,938	2,747,766	2.748
Waikato	338,881	598,696	0.599
Bay of Plenty	786,218	991,424	0.991
Gisborne	11,174	31,423	0.031
Hawkes Bay	179,934	288,169	0.288
Taranaki	36,0144	70,255	0.070
Manawatu/Wanganui	143,263	288,513	0.289
Wellington	198,319	784,118	0.784
Tasman/Nelson	24,364	60,563	0.061
Marlborough	11,781	28,675	0.029
Canterbury	283,361	802,475	0.802
West Coast	11,144	17,402	0.017
Otago	95,931	236,862	0.237
Southland	36,151	80,737	0.081

Table B46 Gravity-based relative estimates for inter-regional paper products trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	1.576	0.294	0.129	0.013	0.060	0.064	0.076	0.136	0.019	0.012	0.095	0.006	0.029	0.016	2.525
A	7.230	–	31.712	10.304	0.766	3.682	3.973	4.437	7.946	0.977	0.620	4.819	0.325	1.413	0.768	78.971
WK	0.961	22.627	–	3.904	0.214	1.132	1.241	1.289	2.135	0.241	0.156	1.165	0.078	0.333	0.179	35.657
BP	1.236	21.545	11.442	–	0.461	1.779	1.602	2.045	3.315	0.385	0.247	1.870	0.126	0.539	0.291	46.883
G	0.022	0.273	0.107	0.079	–	0.081	0.028	0.064	0.102	0.012	0.008	0.058	0.004	0.017	0.009	0.863
HB	0.237	3.171	1.366	0.733	0.196	–	0.422	1.338	1.595	0.146	0.098	0.673	0.045	0.184	0.097	10.299
T	0.059	0.804	0.352	0.155	0.016	0.099	–	0.243	0.364	0.034	0.023	0.160	0.011	0.044	0.023	2.386
MW	0.214	2.726	1.110	0.601	0.110	0.954	0.737	–	3.562	0.195	0.141	0.842	0.056	0.215	0.111	11.575
WT	0.482	6.141	2.313	1.225	0.221	1.431	1.390	4.480	_	0.734	0.595	2.872	0.188	0.679	0.341	23.091
TN	0.026	0.294	0.102	0.055	0.010	0.051	0.051	0.096	0.286	–	0.103	0.302	0.029	0.064	0.031	1.499
M	0.014	0.158	0.056	0.030	0.005	0.029	0.029	0.058	0.196	0.087	–	0.195	0.012	0.035	0.016	0.919
C	0.297	3.275	1.109	0.608	0.111	0.531	0.538	0.931	2.525	0.681	0.520	–	0.416	1.877	0.711	14.131
WC	0.006	0.069	0.023	0.013	0.002	0.011	0.011	0.019	0.052	0.020	0.010	0.130	–	0.025	0.011	0.404
O	0.071	0.754	0.249	0.138	0.025	0.114	0.116	0.187	0.469	0.113	0.073	1.475	0.063	–	0.542	4.390
S	0.022	0.226	0.074	0.041	0.008	0.033	0.034	0.053	0.130	0.030	0.019	0.308	0.015	0.298	–	1.289
Total																234.88

Table B47 Value of petroleum output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	539,139	567,284	0.567
Auckland	17,719	25,093	0.025
Waikato	0	3,869	0.004
Bay of Plenty	10,159	13,196	0.013
Gisborne	0	0	0.000
Hawkes Bay	1,914	1,914	0.002
Taranaki	7,750	7,750	0.008
Manawatu/Wanganui	38	821	0.001
Wellington	5,332	10,546	0.011
Tasman/Nelson	2,285	3,337	0.003
Marlborough	0	0	0.000
Canterbury	15,293	22,409	0.022
West Coast	60	549	0.001
Otago	3,614	5,182	0.005
Southland	1,185	1,926	0.002

Table B48 Gravity-based relative estimates for inter-regional petroleum trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	14.212	2.621	1.207	0.118	0.539	0.560	0.674	1.217	0.164	0.102	0.849	0.056	0.257	0.141	22.717
A	0.062	–	0.297	0.101	0.007	0.035	0.037	0.041	0.075	0.009	0.006	0.045	0.003	0.013	0.007	0.738
WK	0.006	0.152	–	0.027	0.001	0.008	0.008	0.009	0.014	0.002	0.001	0.008	0.0.01	0.002	0.001	0.239
BP	0.015	0.298	0.156	–	0.006	0.024	0.021	0.028	0.045	0.005	0.003	0.026	0.002	0.007	0.004	0.642
G	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HB	0.001	0.022	0.009	0.005	0.001	–	0.003	0.009	0.011	0.001	0.001	0.005	0.000	0.001	0.001	0.070
T	0.006	0.092	0.040	0.018	0.002	0.011	–	0.027	0.041	0.004	0.003	0.018	0.001	0.005	0.003	0.271
MW	0.001	0.008	0.003	0.002	0.000	0.003	0.002	–	0.010	0.001	0.000	0.002	0.000	0.001	0.000	0.034
WT	0.006	0.086	0.032	0.018	0.003	0.020	0.019	0.062	–	0.010	0.008	0.040	0.003	0.009	0.005	0.319
TN	0.001	0.017	0.006	0.003	0.001	0.003	0.003	0.005	0.016	–	0.006	0.017	0.002	0.004	0.002	0.085
M	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000
C	0.008	0.095	0.032	0.018	0.003	0.015	0.015	0.027	0.073	0.019	0.015	–	0.012	0.053	0.020	0.405
WC	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.000	0.004	–	0.001	0.000	0.013
O	0.001	0.017	0.006	0.003	0.001	0.003	0.003	0.004	0.011	0.003	0.002	0.033	0.001	–	0.012	0.098
S	0.000	0.006	0.002	0.001	0.000	0.001	0.001	0.001	0.003	0.001	0.000	0.008	0.000	0.007	–	0.032
Total																25.66

Table B49 Value of chemicals output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	41,778	111,209	0.111
Auckland	1,593,896	2,604,262	2.604
Waikato	193,213	420,830	0.421
Bay of Plenty	149,934	296,902	0.297
Gisborne	3,810	4,896	0.005
Hawkes Bay	61,358	157,213	0.0157
Taranaki	232,792	331,695	0.332
Manawatu/Wanganui	174,984	262,655	0.263
Wellington	504,482	754,435	0.754
Tasman/Nelson	25,590	48,924	0.049
Marlborough	15,218	22,455	0.022
Canterbury	428,865	875,093	0.875
West Coast	5,763	10,422	0.010
Otago	35,152	130,158	0.130
Southland	38,714	94,073	0.094

Table B50 Gravity-based relative estimates for inter-regional chemicals trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	2.691	0.504	0.232	0.023	0.104	1.106	0.129	0.232	0.032	0.020	0.162	0.011	0.050	0.027	4.323
A	6.813	–	30.297	10.308	0.734	3.542	3.658	4.214	7.539	0.928	0.589	4.557	0.309	1.351	0.726	75.565
WK	0.672	15.936	–	2.897	0.152	0.807	0.848	0.908	1.503	0.170	0.110	0.817	0.055	0.237	0.126	25.237
BP	0.368	6.465	3.454	–	0.140	0.541	0.466	0.614	0.994	0.115	0.074	0.559	0.038	0.163	0.087	14.077
G	0.003	0.043	0.017	0.013	–	0.013	0.004	0.010	0.016	0.002	0.001	0.009	0.001	0.003	0.001	0.135
HB	0.129	1.733	0.751	0.422	0.108	–	0.224	0.731	0.871	0.080	0.054	0.366	0.025	0.101	0.053	5.647
T	0.279	3.801	1.675	0.772	0.075	0.475	–	1.148	1.719	0.163	0.109	0.754	0.051	0.210	0.110	11.340
MW	0.193	2.487	1.019	0.578	0.101	0.882	0.652	–	3.246	0.178	0.129	0.765	0.051	0.198	0.101	10.579
WT	0.461	5.920	2.243	1.244	0.215	1.397	1.299	4.319	_	0.708	0.574	2.757	0.181	0.660	0.327	22.305
TN	0.021	0.238	0.083	0.047	0.008	0.042	0.040	0.077	0.231	–	0.083	0.243	0.023	0.052	0.025	1.214
M	0.011	0.124	0.044	0.025	0.004	0.023	0.022	0.046	0.154	0.068	–	0.152	0.010	0.028	0.013	0.722
C	0.322	3.578	1.220	0.700	0.123	0.588	0.570	1.018	2.757	0.744	0.569	–	0.455	2.066	0.774	15.482
WC	0.004	0.041	0.014	0.008	0.001	0.007	0.007	0.012	0.031	0.012	0.006	0.078	–	0.015	0.007	0.242
O	0.039	0.415	0.138	0.080	0.014	0.064	0.062	0.103	0.258	0.062	0.040	0.808	0.034	–	0.297	2.416
S	0.025	0.263	0.087	0.050	0.009	0.039	0.038	0.062	0.151	0.035	0.022	0.358	0.018	0.351	–	1.508
Total																190.79

Table B51 Value of non-metallic products output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	52,041	91,271	0.091
Auckland	177,547	682,868	0.683
Waikato	38,288	149,905	0.150
Bay of Plenty	11,180	66,997	0.067
Gisborne	9,215	16,517	0.017
Hawkes Bay	21,882	67,247	0.067
Taranaki	9,303	28,678	0.029
Manawatu/Wanganui	13,349	65,409	0.065
Wellington	63,474	124,834	0.125
Tasman/Nelson	15,385	40,342	0.040
Marlborough	3,077	7,896	0.008
Canterbury	56,817	229,912	0.230
West Coast	36,254	51,285	0.051
Otago	9,386	51,468	0.051
Southland	11,939	41,657	0.042

Table B52 Gravity-based relative estimates for inter-regional non-metallic products trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	2.267	0.419	0.193	0.019	0.086	0.090	0.108	0.195	0.026	0.016	0.136	0..009	0.041	0.023	3.628
A	1.791	–	8.041	2.750	0.192	0.938	0.992	1.122	2.023	0.224	0.155	1.220	0.079	0.357	0.192	20.095
WK	0.240	5.827	–	1.050	0.054	0.290	0.312	0.329	0.548	0.061	0.039	0.297	0.019	0.085	0.045	9.196
BP	0.083	1.497	0.789	–	0.031	0.123	0.109	0.141	0.230	0.026	0.017	0.129	0.008	0.037	0.020	3.240
G	0.011	0.148	0.057	0.044	–	0.044	0.015	0.034	0.055	0.006	0.004	0.031	0.002	0.009	0.005	0.466
HB	0.055	0.761	0.325	0.184	0.046	–	0.099	0.318	0.381	0.034	0.023	0.160	0.010	0.044	0.023	2.463
T	0.024	0.337	0.147	0.068	0.006	0.041	–	0.101	0.152	0.014	03.009	0.067	0.004	0.018	0.010	0.999
MW	0.048	0.636	0.257	0.146	0.025	0.222	0.168	–	0.827	0.044	0.032	0.194	0.012	0.050	0.025	2.688
WT	0.077	1.005	0.376	0.209	0.035	0.234	0.222	0.726	_	0.117	0.095	0.466	0.029	0.110	0.055	3.756
TN	0.017	0.201	0.069	0.040	0.007	0.035	0.034	0.065	0.195	–	0.069	0.205	0.019	0.043	0.021	1.019
M	0.004	0.045	0.016	0.009	0.002	0.008	0.008	0.016	0.055	0.024	–	0.055	0.003	0.010	0.005	0.258
C	0.085	0.965	0.324	0.187	0.032	0.156	0.155	0.272	0.741	0.196	0.150	–	0.117	0.543	0.205	4.131
WC	0.018	0.209	0.070	0.040	0.007	0.034	0.033	0.058	0.156	0.060	0.030	0.390	–	0.075	0.033	1.214
O	0.015	0.169	0.055	0.032	0.006	0.025	0.025	0.041	0.104	0.025	0.016	0.326	0.013	–	0.118	0.972
S	0.011	0.120	0.039	0.023	0.004	0.018	0.018	0.028	0.069	0.016	0.010	0.162	0.008	0.156	–	0.679
Total																54.80

Table B53 Value of basic and fabricated metals output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	55,407	98,534	0.099
Auckland	966,966	2,313,566	2.314
Waikato	300,943	535,424	0.535
Bay of Plenty	51,123	160,429	0.160
Gisborne	9,869	21,314	0.021
Hawkes Bay	54,157	114,532	0.125
Taranaki	246,526	312,773	0.313
Manawatu/Wanganui	92,199	193,169	0.193
Wellington	198,617	406,289	0.406
Tasman/Nelson	39,619	68,830	0.069
Marlborough	9628	26,971	0.027
Canterbury	189,087	572,463	0.572
West Coast	3,525	5,582	0.006
Otago	95,623	168,639	0.169
Southland	37,8014	447,678	0.448

Table B54 Gravity-based relative estimates for inter-regional basic and fabricated metals trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	2.393	0.445	0.207	0.020	0.092	0.094	0.115	0.208	0.028	0.017	0.145	0.010	0.044	0.023	3.843
A	6.062	–	26.777	9.253	0.648	3.161	3.257	3.764	6.785	0.821	0.523	4.087	0.275	1.196	0.614	67.222
WK	0.856	20.357	–	3.724	0.192	1.032	1.081	1.162	1.936	0.215	0.139	1.049	0.070	0.300	0.152	32.267
BP	0.199	3.507	1.857	–	0.075	0.294	0.252	0.344	0.544	0.062	0.040	0.305	0.020	0.088	0.045	7.621
G	0.015	0.186	0.073	0.057	–	0.056	0.018	0.334	0.070	0.008	0.005	0.040	0.003	0.012	0.006	0.592
HB	0.094	1.268	0.544	0.311	0.078	–	0.163	0.536	0.643	0.058	0.039	0.269	0.018	0.073	0.037	4.131
T	0.263	3.599	1.571	0.736	0.070	0.450	–	1.089	1.642	0.153	0.102	0.718	0.048	0.197	0.098	10.737
MW	0.142	1.836	0.745	0.429	0.074	0.652	0.481	–	2.418	0.131	0.094	0.568	0.038	0.145	0.070	7.824
WT	0.249	3.201	1.202	0.677	0.115	0.756	0.701	2.339	_	0.380	0.308	1.499	0.098	0.354	0.168	12.046
TN	0.029	0.336	0.116	0.067	0.012	0.059	0.057	0.110	0.329	–	0.117	0.345	0.033	0.073	0.033	1.716
M	0.013	0.149	0.052	0.030	0.005	0.028	0.026	0.055	0.187	0.082	–	0.185	0.012	0.033	0.015	0.871
C	0.211	2.350	0.794	0.463	0.080	0.386	0.373	0.669	1.827	0.485	0.371	–	0.298	1.347	0.482	10.136
WC	0.002	0.022	0.008	0.004	0.001	0.004	0.004	0.006	0.017	0.006	0.003	0.042	–	0.008	0.003	0.130
O	0.050	0.540	0.178	0.105	0.018	0.083	0.081	0.134	0.339	0.081	0.052	1.058	0.045	–	0.366	3.129
S	0.119	1.259	0.411	0.242	0.042	0.187	0.183	0.297	0.729	0.166	0.104	1.719	0.086	1.663	–	7.207
Total																169.47

Table B55 Value of equipment and machinery metals output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	117,849	218,355	0.218
Auckland	1,398,265	3,588,239	3.588
Waikato	384,040	785,343	0.785
Bay of Plenty	216,001	491,681	0.492
Gisborne	15,238	34,095	0.034
Hawkes Bay	113,098	235,413	0.235
Taranaki	125,368	204,196	0.204
Manawatu/Wanganui	168,907	410,944	0.411
Wellington	289,205	675,469	0.675
Tasman/Nelson	51,475	118,728	0.119
Marlborough	70,856	107,104	0.107
Canterbury	930,027	1,841,205	1.841
West Coast	28,495	37,690	0.038
Otago	186,331	366,247	0.366
Southland	57,827	116,465	0.116

Table B56 Gravity-based relative estimates for inter-regional equipment and machinery metals trade.

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Check
N	–	5.211	0.974	0.448	0.045	0.202	0.211	0.251	0.457	0.062	0.038	0.308	0.021	0.096	0.053	8.378
A	9.259	–	41.062	13.994	0.999	4.837	5.113	5.736	10.418	1.262	0.789	6.083	0.420	1.824	0.997	102.793
WK	1.236	29.337	–	5.326	0.280	1.493	1.605	1.674	2.812	0.313	0.199	1.477	0.102	0.433	0.234	46.522
BP	0.601	10.561	5.627	–	0.228	0.887	0.783	1.004	1.651	0.189	0.119	0.897	0.062	0.265	0.144	23.017
G	0.023	0.293	0.115	0.089	–	0.089	0.030	0.069	0.111	0.013	0.008	0.061	0.004	0.018	0.010	0.932
HB	0.190	2.560	1.106	0.622	0.160	–	0.340	1.082	1.308	0.118	0.078	0.531	0.036	0.149	0.079	8.360
T	0.169	2.308	1.014	0.468	0.045	0.290	–	0.698	1.061	0.099	0.065	0.450	0.031	0.127	0.067	6.894
MW	0.298	3.838	1.568	0.890	0.157	1.368	1.035	–	5.094	0.275	0.195	1.159	0.079	0.303	0.157	16.416
WT	0.407	5.228	1.975	1.098	0.190	1.240	1.180	3.821	_	0.625	0.499	2.391	0.160	0.579	0.292	19.686
TN	0.050	0.570	0.198	0.113	0.020	0.100	0.099	0.186	0.563	–	0.196	0.572	0.055	0.124	0.060	2.905
M	0.049	0.582	0.206	0.117	0.020	0.109	0.106	0.216	0.734	0.321	–	0.703	0.045	0.129	0.061	3.399
C	0.668	7.427	2.524	1.451	0.255	1.225	1.216	2.116	5.817	1.545	1.162	–	0.944	4.259	1.624	32.235
WC	0.013	0.148	0.050	0.029	0.005	0.024	0.024	0.041	0.112	0.043	0.021	0.272	–	0.053	0.024	0.861
O	0.108	1.153	0.383	0.221	0.039	0.177	0.177	0.287	0.729	0.173	0.111	2.204	0.096	–	0.833	6.690
S	0.031	0.322	0.106	0.061	0.011	0.048	0.048	0.076	0.188	0.043	0.026	0.429	0.022	0.425	–	1.836
Total																280.92

Table B57 Value of services output and exports for all regions.

Region	Exports ($thousand)	Output ($thousand)	Output ($million)
Northland	1,295,288	4,259,076	4.259
Auckland	13,957,038	56,011,019	56.011
Waikato	2,663,349	12,382,317	12.382
Bay of Plenty	1,905,358	8,104,313	8.104
Gisborne	413,350	1,333,174	1.333
Hawkes Bay	1,342,952	4,883,932	4.884
Taranaki	2,669,055	5,130,983	5.131
Manawatu/Wanganui	1,795,912	7,758,774	7.759
Wellington	5,499,842	22,848,638	22.849
Tasman/Nelson	881,152	3,026,047	3.026
Marlborough	542,889	1,453,007	1.453
Canterbury	4,266,058	20,436,543	20.437
West Coast	459,938	1,076,442	1.076
Otago	2,048,693	7,245,229	7.245
Southland	1,198,339	3,263,806	3.264

Table B58 Gravity-based relative estimates for inter-regional services trade.

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	Check
N	–	81.667	44.023	22.943	4.349	17.998	17.451	20.906	19.947	9.961	6.592	48.961	4.678	19.966	17.278	336.720
A	207.246	–	578.951	301.727	57.194	236.698	229.494	274.929	262.319	130.991	86.693	643.880	61.523	262.575	227.225	3561.442
WK	45.816	237.427	–	66.703	12.644	52.327	50.734	60.778	57.991	28.958	19.165	142.342	13.601	58.047	50.232	896.765
BP	29.987	155.398	83.769	–	8.275	34.248	33.206	39.780	37.955	18.953	12.544	93.164	8.902	37.992	32.877	627.051
G	4.933	25.563	13.780	7.182	–	5.634	5.462	6.544	6.244	3.118	2.063	15.326	1.464	6.250	5.408	108.971
HB	18.071	93.648	50.482	26.309	4.987	–	20.011	23.973	22.873	11.422	7.559	56.144	5.365	22.895	19.813	383.552
T	18.985	98.385	53.036	27.640	5.239	21.683	–	25.185	24.030	12.000	7.942	58.984	5.636	24.054	20.815	403.614
MW	28.708	148.772	80.198	41.796	7.923	32.788	31.790	–	36.337	18.145	12.009	89.192	8.522	36.372	31.476	604.028
WT	84.542	438.116	236.172	123.084	23.331	96.556	93.618	112.152	_	53.435	35.365	262.659	25.097	107.112	92.692	1783.931
TN	11.197	58.024	31.278	16.301	3.090	12.788	12.399	14.853	14.172	–	4.684	34.786	3.324	14.186	12.276	243.357
M	5.376	27.861	15.019	7.827	1.484	6.140	5.953	7.132	6.805	3.398	–	16.703	1.596	6.812	5.895	118.001
C	75.617	391.865	211.240	110.090	20.868	86.363	83.735	100.312	95.711	47.794	31.631	–	22.448	95.805	82.907	1456.386
WC	3.983	20.640	11.127	5.799	1.099	4.549	4.411	5.284	5.041	2.517	1.666	12.374	–	5.046	4.367	87.903
O	26.808	138.925	74.889	39.029	7.398	30.618	29.686	35.563	33.932	16.944	11.214	83.288	7.958	–	29.392	565.646
S	12.076	62.583	33.736	17.582	3.333	13.793	13.373	16.020	15.286	7.633	5.052	37.519	3.585	15.300	–	256.870
Total																11 434.24

The gravity model is probably invalid for services, as it leads to negative imports from overseas to Waikato because Auckland has probably been given too high a weighting relative to Waikato (302 v. 1853 = 16.3%). Ignoring the distance, the weighting for these two regions is 579 v. 11 434 = 5.1%).

B3.6 Absolute dollar values

In this section, the columns headed 'Domestic imports' derive the values of total domestic exports from each region (by industry) by subtracting overseas exports from total exports, where overseas exports from each region (for each industry) are determined in accordance with Equations A16 and A17. The 'Destination' columns yield the dollar value of trade flows using Equations A18 and A19.

Table B59 Estimated exports in horticulture from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	129,098	40,240
Auckland	211,709	65,990
Waikato	102,942	32,087
Bay of Plenty	438,297	136,619
Gisborne	130,589	40,705
Hawkes Bay	211,449	65,909
Taranaki	9,258	2,886
Manawatu/Wanganui	128,747	40,131
Wellington	48,507	15,120
Tasman/Nelson	136,749	42,625
Marlborough	57,201	17,830
Canterbury	260,429	81,177
West Coast	1,215	379
Otago	27,546	8,586
Southland	696	217
Total	1,894,431	590,501
Value of overseas exports ($ thousand): 1,303,930		

Table B60 Estimated inter-regional trade in horticulture (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	25 317	4622	2075	196	926	996	1180	2172	284	176	1494	101	455	249	88 858
A	5874	–	26 560	8831	596	3020	3288	3677	6750	790	500	4021	269	1179	635	145 718
WK	828	20 512	–	3549	177	984	1089	1133	1924	207	133	1031	69	295	157	70 855
BP	3470	63 658	33 125	–	1239	5042	4583	5859	9734	1075	689	5395	361	1556	832	301 678
G	996	13 080	5017	3772	–	3727	1281	2969	4849	542	347	2730	183	790	423	89 884
HB	1466	20 606	8698	4774	1159	–	2656	8428	10 300	894	600	4268	283	1167	611	145 540
T	69	986	423	191	17	117	–	289	443	40	27	192	13	53	28	6372
MW	714	9596	3828	2121	353	3223	2513	–	12 461	650	468	2893	190	741	378	88 616
WT	307	4110	1517	822	134	919	901	2907	_	464	376	1876	122	444	221	33 387
TN	712	8529	2891	1611	267	1416	1437	2691	8240	–	2814	8540	802	1810	864	94 124
M	254	3121	1077	597	99	549	554	1119	3851	1626	–	3762	234	676	312	39 372
C	1653	19 184	6368	3571	593	2984	3049	5289	14 702	3772	2876	–	2362	10 740	4035	179 252
WC	6	66	22	12	2	10	10	18	49	18	9	122	–	23	10	836
O	135	1507	488	276	46	218	225	362	932	214	138	2876	121	–	1047	18 960
S	4	39	12	7	1	5	6	9	22	5	3	52	3	50	–	479
Total	16 490	190 309	94 648	32 207	4878	23 141	22 587	35 930	76 429	10 582	9157	39 250	5112	19 980	9802	1 303 930

Table B61 Estimated exports in pastoral agriculture from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	237,288	209,192
Auckland	207,561	182,985
Waikato	1,080,045	952,163
Bay of Plenty	153,583	135,398
Gisborne	168,689	148,715
Hawkes Bay	55,789	49,183
Taranaki	54,199	47,781
Manawatu/Wanganui	496,073	437,336
Wellington	288,926	254,716
Tasman/Nelson	84,842	74,797
Marlborough	30,090	26,527
Canterbury	179,667	158,393
West Coast	45,481	40,096
Otago	106,502	93,891
Southland	0	0
Total	3,188,735	2,811,175
Value of overseas exports ($ thousand): 377,560		

Table B62 Estimated inter-regional trade in pastoral agriculture (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	134 636	21 837	10 975	1015	4789	4732	5753	11 410	1504	912	7719	485	2262	1164	28 096
A	16 182	–	70 330	26 181	1733	8753	8755	10 049	19 875	2343	1457	11 648	728	3287	1664	24 576
WK	23 019	616 619	–	106 147	5179	28 786	29 267	31 236	57 144	6187	3918	30 124	1878	8301	4160	127 882
BP	3315	65 801	30 418	–	1249	5069	4232	5554	9939	1106	696	5420	338	1504	756	18 185
G	3484	49 498	16 868	14 197	–	13 718	4330	10 301	18 125	2042	1283	10 040	627	2796	1408	19 973
HB	1052	15 997	5999	3686	878		1842	6000	7899	691	455	3220	200	847	417	6 606
T	1098	16 909	6445	3252	293	1947	–	4540	7514	681	446	3195	198	846	417	6417
MW	7420	107 844	38 221	23 714	3870	35 230	25 228	–	138 337	7273	5142	31 602	1941	7782	3734	58 737
WT	5007	72 565	23 789	14 439	2317	15 780	14 204	47 064	_	8162	6483	32 195	1955	7332	3425	34 210
TN	1198	15 516	4673	2914	474	2505	2336	4489	14 807	–	5003	15 098	1324	3079	1381	10 046
M	361	4799	1471	912	148	821	761	1578	5848	2488	–	5621	326	972	421	3563
C	3111	39 060	11 518	7231	1179	5908	5547	9875	29 570	7644	5723	–	4361	20 447	7220	21 273
WC	581	7257	2133	1341	219	1088	1022	1802	5334	1991	986	12 958	–	2391	994	5385
O	1423	17 201	4953	3132	512	2425	2292	3795	10 508	2433	1545	31 908	1256	–	10 509	12 610
S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0
Total	67 252	1 163 903	238 656	218 120	19 063	126 817	104 547	142 034	336 310	44 544	34 049	200 746	15 615	61 847	37 671	377 560

Table B63 Estimated exports in forestry from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	216,526	90,053
Auckland	62,726	26,088
Waikato	364,393	151,551
Bay of Plenty	127,361	52,969
Gisborne	151,154	62,865
Hawkes Bay	111,000	46,165
Taranaki	10,911	4,538
Manawatu/Wanganui	61,928	25,756
Wellington	59,907	24,915
Tasman/Nelson	92,485	38,464
Marlborough	57,150	23,769
Canterbury	66,800	27,782
West Coast	33,993	14,138
Otago	30,798	12,809
Southland	5153	2143
Total	1,452,285	604 005
Value of overseas exports ($ thousand): 848 280		

Table B64 Estimated inter-regional trade in forestry (in thousands of dollars).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Z**
N	–	56 730	10 151	4687	435	2112	2235	2657	4846	636	395	3378	218	1015	557	126 473
A	2302	–	10 367	3546	236	1224	1311	1472	2676	314	200	1617	104	468	253	36 638
WK	3844	96 764	–	16 879	827	4726	5147	5371	9035	974	632	4909	315	1387	741	212 842
BP	1330	24 791	12 644	–	479	1999	1788	2294	3774	418	270	2121	136	604	324	74 392
G	1514	20 203	7596	5873	–	5860	1981	4609	7457	836	538	4257	273	1216	653	88 289
HB	1012	14 463	5983	3378	807	–	1867	5946	7198	627	423	3024	193	816	428	64 835
T	107	1553	653	303	27	187	–	457	695	63	42	305	19	83	44	6373
MW	452	6166	2411	1374	225	2108	1617	–	7972	417	302	1877	119	474	242	36 172
WT	497	6765	2447	1364	220	1540	1485	4810	_	763	621	3118	195	728	363	34 992
TN	632	7696	2557	1465	239	1300	1299	2440	7402	–	2550	7778	702	1626	778	54 020
M	333	4161	1407	802	130	745	739	1500	5111	2164	–	5062	302	898	415	33 381
C	558	6584	2142	1235	202	1042	1048	1825	5024	1292	991	–	786	3670	1382	39 018
WC	210	2467	800	462	76	387	390	671	1828	679	344	4575	–	866	384	19 855
O	198	2244	713	414	68	331	335	543	1382	318	207	4324	175	–	1557	17 989
S	34	383	120	70	12	55	56	88	217	48	30	514	25	492	–	3010
Total	13 023	250 970	59 989	41 854	3982	23 616	21 299	34 682	64 617	9549	7545	46 858	3561	14 340	8120	848 280

Table B65 Estimated exports in fishing from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	88,161	54,266
Auckland	117,094	72,076
Waikato	76,324	46,980
Bay of Plenty	12,113	7,456
Gisborne	12,752	7,850
Hawkes Bay	13,073	8,047
Taranaki	10,240	6,303
Manawatu/Wanganui	5491	3,380
Wellington	31,518	19,400
Tasman/Nelson	0	0
Marlborough	108,904	67,035
Canterbury	0	0
West Coast	8136	5,008
Otago	0	0
Southland	44,853	27,609
Total	528,659	325,409
Value of overseas exports ($ thousand): 203,250		

Table B66 Estimated inter-regional trade in fishing (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	33 992	6252	2883	280	1289	1342	1613	2911	372	227	2025	133	614	332	33 895
A	6401	–	28 884	9867	685	3378	3562	4042	7274	831	520	4383	287	1280	681	45 018
WK	1216	29 845	–	5345	274	1484	1591	1678	2794	293	187	1515	99	432	228	29 344
BP	190	3458	1813	–	72	284	250	324	528	57	36	296	19	85	45	4657
G	192	2500	966	746	–	738	246	578	925	101	64	527	34	152	80	4903
HB	179	2498	1062	599	150	–	323	1040	1247	106	70	523	34	142	74	5026
T	152	2138	924	428	40	262	–	637	960	84	56	420	27	115	60	3937
MW	60	804	323	184	31	280	211	–	1042	53	38	245	16	62	31	2111
WT	394	5227	1943	1082	182	1211	1149	3765	_	576	460	2410	153	568	279	12 117
TN	0	0	0	0	0	0	0	0	0	–	0	0	0	0	0	0
M	961	11 690	4064	2313	393	2130	2081	4269	14 397	5938	–	14 226	865	2547	1161	41 870
C	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0
WC	76	871	290	167	29	139	138	240	647	234	117	1616	–	309	135	3128
O	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0
S	450	4899	1584	922	158	715	714	1137	2791	601	371	6586	320	6360	–	17244
Total	10 272	97 920	48 105	24 536	2294	11 911	11 607	19 324	35 515	9247	2145	34 770	1989	12 997	3106	203 250

Table B67 Estimated exports in mining from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	82,090	44,861
Auckland	75,251	41,124
Waikato	258,025	141,007
Bay of Plenty	23,380	12,777
Gisborne	1,049	573
Hawkes Bay	31,051	16,969
Taranaki	698	381
Manawatu/Wanganui	19,383	10,593
Wellington	29,150	15,930
Tasman/Nelson	14,711	8,039
Marlborough	30,051	16,423
Canterbury	24,211	13,231
West Coast	226,685	123,880
Otago	124,087	67,812
Southland	28,068	15,339
Total	967,890	528,940
Value of overseas exports ($ thousand): 438,950		

Table B68 Estimated inter-regional trade in mining (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	28 131	5113	2388	233	1064	1109	1332	2409	325	199	1680	99	503	276	37 229
A	3673	–	16 352	5657	395	1932	2037	2310	4166	502	316	2517	148	727	392	34 127
WK	3656	89 546	–	16 047	827	4445	4766	5024	8382	928	595	4555	267	1284	686	117 017
BP	327	5940	3077	–	124	487	429	555	907	103	66	510	30	145	78	10 603
G	14	183	70	55	–	54	18	42	68	8	5	39	2	11	6	476
HB	379	5273	2216	1265	318	–	681	2191	2631	235	157	1106	64	297	156	14 082
T	9	130	55	26	2	16	–	39	58	5	4	25	1	7	4	317
MW	190	2519	1000	577	99	875	661	–	3256	176	126	796	44	194	99	8790
WT	324	4289	1576	889	151	992	942	3082	_	499	401	1982	113	462	230	13 220
TN	135	1600	540	313	54	275	270	513	1543	–	540	1622	134	338	162	6671
M	235	2856	981	565	97	519	508	1040	3516	1530	–	3484	190	616	285	13 629
C	272	3120	1031	601	104	502	497	874	2386	631	478	–	341	1740	655	10 980
WC	1879	21 470	7074	4131	711	3423	3392	5906	15 947	6087	3049	39 935	–	7537	3340	102 804
O	1070	11 825	3816	2242	387	1773	1768	2890	7300	1728	1110	22 849	846	–	826	56 275
S	251	2726	871	513	89	397	397	631	1553	353	219	3674	160	3505	–	12 729
Total	12 414	179 607	43 771	35 270	3591	16 754	17 474	26 428	54 130	13 110	7264	84 747	2442	17 365	14 574	438 950

Table B69 Estimated exports in meat processing from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	160,084	35,851
Auckland	119,975	26,868
Waikato	542,451	121,482
Bay of Plenty	161,659	36,203
Gisborne	23,620	5,290
Hawkes Bay	742,526	166,288
Taranaki	450,082	100,796
Manawatu/Wanganui	389,098	87,138
Wellington	159,166	35,645
Tasman/Nelson	36,538	8,183
Marlborough	106,027	23,745
Canterbury	794,559	177,941
West Coast	41,688	9,336
Otago	865,589	193,848
Southland	1,039,886	232,882
Total	5,632,946	1,261,496
Value of overseas exports ($ thousand): 4,371,450		

Table B70 Estimated inter-regional trade in meat processing (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	22 725	4054	1906	188	779	849	1033	1935	261	156	1309	89	376	191	124 233
A	2434	–	10 749	3743	264	1172	1294	1486	2775	335	206	1627	110	450	224	93 106
WK	3149	77 973	–	13 806	717	3507	3934	4202	7259	805	503	3827	257	1033	510	420 970
BP	932	17 093	8691	–	355	1269	1169	1535	2595	296	184	1415	95	385	191	125 456
G	131	1726	647	509	–	461	161	382	635	73	45	352	24	96	48	18 330
HB	3739	52 539	21 669	12 456	3156	–	6434	20 969	26 069	2335	1519	10 628	709	3739	1327	576 238
T	2449	34 834	14 604	6893	660	3866	–	9953	15 555	1444	933	6613	442	1716	834	349 286
MW	1575	21 156	8247	4786	831	6662	5262		27 271	1468	1024	6230	412	1503	710	301 959
WT	737	9875	3561	2022	345	2070	2055	6816	_	1143	896	4403	288	982	452	123 521
TN	139	1669	553	323	56	260	267	514	1600	–	546	1632	154	326	144	28 355
M	344	4222	1423	826	142	696	711	1477	5170	2252	–	4969	310	842	360	82 282
C	3717	43 125	13 987	8214	1425	6288	6512	11 602	32 806	8682	6416	–	5212	22 223	7733	616 618
WC	144	1667	539	317	55	241	250	440	1231	470	230	2990	–	541	221	32 352
O	3140	35 086	11 113	6574	1144	4769	4971	8237	21 539	5105	3200	65 403	2773	–	20 795	671 740
S	3895	42 793	13 417	7961	1388	5650	5906	9520	24 241	5517	3342	55 637	2776	50 839	–	807 004
Total	26 528	366 482	113 253	70 337	10 727	37 689	39 775	78 167	170 683	30 185	19 199	167 032	13 650	84 048	33 739	4 371 450

Table B71 Estimated exports in dairy processing from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	431,238	81,974
Auckland	1,073,330	204,029
Waikato	1,476,170	280,604
Bay of Plenty	356,201	67,710
Gisborne	4,734	900
Hawkes Bay	11,834	2,250
Taranaki	1,098,745	208,860
Manawatu/Wanganui	374,815	71,248
Wellington	108,044	20,538
Tasman/Nelson	85,521	16,257
Marlborough	68,995	13,115
Canterbury	778,630	148,009
West Coast	176,443	33,540
Otago	333,928	63,476
Southland	381,512	72,521
Total	6,760,142	1,285,032
Value of overseas exports ($ thousand)		5,475,110

Table B72 Estimated inter-regional trade in dairy processing (in thousands of dollars).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Z**
N	–	51 848	9015	4324	436	1998	1819	2414	4494	596	366	3057	191	923	491	349 264
A	18 060	–	79 857	28 372	2049	10 045	9254	11 599	21 533	2554	1610	12 686	790	3688	1930	869 301
WK	7053	179 348	–	31 579	1681	9069	8493	9897	16 996	1852	1188	9007	559	2557	1325	1 195 566
BP	1696	31 952	15 835	–	677	2667	2051	2939	4937	553	353	2706	168	774	402	288 491
G	22	290	106	85	–	87	25	66	109	12	8	60	4	17	9	3834
HB	49	708	285	167	43	–	81	290	358	32	21	147	9	40	20	9585
T	4895	71 517	29 224	14 074	1383	8922	–	20 927	32 509	2966	1968	13 894	858	3791	1932	889 885
MW	1239	17 084	6491	3844	685	6047	3989	–	22 417	1186	850	5148	315	1306	648	303 566
WT	409	5623	1976	1145	200	1325	1098	3974	–	651	524	2565	155	602	291	87 506
TN	266	3265	1054	627	111	571	491	1029	3187	–	1098	3267	285	686	318	69 265
M	182	2299	756	447	79	426	364	824	2867	1227	–	2769	160	494	221	55 880
C	2955	35 204	11 129	6668	1186	5770	4989	9699	27 261	7092	5381	–	4026	19 524	7125	630 621
WC	496	5877	1852	1111	198	955	826	1590	4419	1660	833	10 791	–	2052	881	142 903
O	978	11 221	3464	2091	373	1714	1492	2698	7012	1634	1051	21 403	839	–	7506	270 452
S	1153	13 010	3976	2407	430	1931	1685	2964	7502	1678	1044	17 309	799	16634	–	308 991
Total	39 452	429 246	165 021	96 942	9533	51 528	36 658	70 909	155 600	23 693	16 295	104 810	9130	53 087	23 099	5 475 110

Table B73 Estimated exports in other food, beverages and tobacco from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	38,305	18,762
Auckland	1,422,366	696,703
Waikato	102,518	50,215
Bay of Plenty	200,573	98,245
Gisborne	155,772	76,300
Hawkes Bay	693,042	339,466
Taranaki	74,775	36,626
Manawatu/Wanganui	207,116	101,450
Wellington	202,790	99,331
Tasman/Nelson	597,173	292,507
Marlborough	429,821	210,535
Canterbury	882,135	432,087
West Coast	53,085	26,002
Otago	277,426	135,889
Southland	119,191	58,382
Total	5,456,089	2,672,499
Value of overseas exports ($thousand): 2,783,590		

Table B74 Estimated inter-regional trade in other food, beverage and tobacco (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	11 710	2218	1003	92	417	474	559	1026	123	73	694	47	211	118	19 542
A	63 349	–	282 874	94 705	6224	30 153	34 756	38 681	70 774	7556	4600	41 465	2793	12 117	6656	725 663
WK	1351	31 842	–	5755	279	1486	1742	1802	3050	299	185	1607	108	459	249	52 303
BP	2590	45 217	24 411	–	895	3484	3352	4265	7062	712	439	3849	259	1106	603	102 329
G	1939	24 237	9646	7301	–	6719	2444	5637	9176	937	576	5081	342	1466	801	79 472
HB	7808	104 458	45 744	25 280	5977	–	13 867	43 786	53 330	4226	2725	21 734	1451	5920	3159	353 577
T	912	12 348	5496	2494	223	14 22	–	3706	5673	466	299	2411	161	661	354	38 149
MW	1876	23 981	9926	5538	898	7836	6466	–	31 806	1515	1048	7263	481	1852	964	105 667
WT	2100	26 771	10 249	5595	891	5823	6040	19 406	–	2820	2192	12 277	803	2895	1467	103 460
TN	5107	58 204	20 469	11 482	1853	9398	10 100	18 819	57 428	–	17 202	58 537	5529	12 363	6017	304 666
M	3133	36 633	13115	7316	1177	6265	6692	13 462	46 159	17 786	–	44 347	2769	7944	3736	219 286
C	9187	101 479	34 947	19 731	3194	15 354	16 610	28 672	79 430	18 598	13 627	–	12 618	56 858	21 783	450 048
WC	411	4523	1553	878	142	678	734	1255	3438	1162	563	8349	–	1595	719	27 083
O	2222	23 639	7950	4521	734	3334	3631	5828	14 932	3131	1946	45 325	1922	–	16 773	141 538
S	990	10 359	3448	1967	320	1419	1550	2420	6038	1216	730	13 853	691	13 381	–	60 809
Total	102 975	515 403	472 046	193 566	22 899	93 787	108 459	188 299	389 323	60 545	46 203	266 794	29 974	118 827	63 399	2 783 590

Table B75 Estimated exports in textiles from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	17,403	6,896
Auckland	394,367	156,265
Waikato	33,668	13,341
Bay of Plenty	21,930	8,690
Gisborne	16,510	6,542
Hawkes Bay	182,285	72,229
Taranaki	16,474	6,528
Manawatu/Wanganui	214,977	85,183
Wellington	66,614	26,395
Tasman/Nelson	15,010	5,948
Marlborough	6,581	2,608
Canterbury	434,875	172,316
West Coast	1,273	504
Otago	133,540	52,914
Southland	50,837	20,144
Total	1,606,343	636,503
Value of overseas exports ($ thousand): 969,840		

Table B76 Estimated inter-regional trade in textiles (in thousands of dollars).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Z**
N	–	4310	801	369	36	161	172	202	371	50	31	255	17	78	43	10 507
A	14 057	–	62 761	21 434	1490	7175	7727	8563	15 727	1903	1208	9354	633	2744	1489	238 101
WK	352	8456	–	1530	78	416	455	469	796	88	57	426	29	122	66	20 327
BP	226	4015	2128	–	84	326	293	371	616	70	45	341	23	98	53	13 240
G	163	2077	812	627	–	606	206	473	773	89	57	435	29	126	68	9968
HB	1639	22 343	9604	5414	1354	–	2917	9173	11 214	1007	677	4639	311	1269	669	110 056
T	160	2207	964	446	42	268	–	649	997	93	62	430	29	118	63	9946
MW	1547	20 149	8186	4659	798	6931	5344	–	26 272	1418	1023	6090	405	1559	802	129 794
WT	546	7094	2666	1484	250	1624	1574	5036	–	832	675	3246	213	769	385	40 219
TN	101	1178	407	233	40	200	201	373	1143	–	405	1183	112	251	121	9062
M	38	452	159	90	15	81	81	163	560	244	–	546	34	98	46	3973
C	3578	40 261	13 609	7838	1342	6413	6482	11 141	30 980	8220	6281	–	5019	22 600	8554	262 558
WC	8	87	29	17	3	14	14	24	65	25	13	161	–	31	14	768
O	849	9204	3038	1762	303	1366	1391	2223	5715	1358	880	17 611	750	–	6464	80625
S	335	3569	1166	679	117	515	525	817	2045	467	292	4762	239	4618	–	30 693
Total	23 600	125 403	106 328	46 583	5952	26 096	27 382	39 675	97 275	15 866	11 707	49 479	7844	34 480	18 834	969 840

Table B77 Estimated exports in wood products from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	102,650	36,231
Auckland	143,547	50,665
Waikato	401,764	141,804
Bay of Plenty	332,671	117,417
Gisborne	44,099	15,565
Hawkes Bay	48,367	17,071
Taranaki	76,816	27,112
Manawatu/Wanganui	90,612	31,982
Wellington	106,070	37,438
Tasman/Nelson	137,143	48,405
Marlborough	21,361	7539
Canterbury	158,358	55,893
West Coast	68,202	24,072
Otago	113,282	39,983
Southland	119,347	42,124
Total	1,964,291	693,301
Value of overseas exports ($ thousand): 1,270,990		

Table B78 Estimated inter-regional trade in wood products (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	22 784	4116	1878	186	862	894	1072	1948	256	162	1353	88	408	222	66 420
A	4539	–	20 187	6823	483	2399	2518	2851	5168	607	393	3110	200	904	484	92 882
WK	3674	90 427	–	15 738	821	4489	4789	5042	8453	912	601	4576	294	1298	688	259 961
BP	3002	54 725	28 181	–	1123	4485	3929	5086	8341	925	606	4670	300	1335	710	215 254
G	382	4985	1893	1446	–	1473	487	1142	1842	207	135	1048	67	301	160	28 534
HB	382	5331	2227	1242	316	–	685	2202	2656	232	159	1112	71	301	157	31 296
T	654	9245	3925	1798	173	1132	–	2733	4145	374	255	1810	116	493	257	49 704
MW	572	7632	3013	1697	296	2652	1993	–	9879	517	381	2317	147	588	298	58 630
WT	761	10 129	3699	2038	349	2343	2213	7234	–	1145	947	4656	291	1092	540	68 632
TN	811	9656	3239	1834	319	1658	1623	3076	9298	–	3260	9735	880	2045	970	88 738
M	108	1318	450	253	44	240	233	477	1620	687	–	1599	96	285	131	13 821
C	1145	13 203	4337	2472	431	2125	2093	3676	10 086	2598	2025	–	1574	7374	2755	102 465
WC	365	4194	1373	784	137	669	659	1147	3111	1157	596	7759	–	1474	648	44 130
O	630	7001	2246	1289	225	1050	1041	1701	4316	996	658	13 456	546	–	4828	73 299
S	687	7506	2383	1373	240	1094	1087	1728	4269	946	604	10 062	480	9664	–	77 224
Total	17 712	248 136	81 269	40 667	5141	26 669	24 244	39 167	75 132	11 558	10 783	67 262	5150	27 562	12 849	1 270 990

Table B79 Estimated exports in paper products from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	27,681	13,577
Auckland	888,938	435,990
Waikato	338,881	166,208
Bay of Plenty	786,218	385,609
Gisborne	11,174	5480
Hawkes Bay	179,934	88,251
Taranaki	36,014	17,663
Manawatu/Wanganui	143,263	70,265
Wellington	198,319	97,268
Tasman/Nelson	24,364	11,950
Marlborough	11,781	5778
Canterbury	283,361	138,978
West Coast	11,144	5466
Otago	95,931	47,050
Southland	36,151	17,731
Total	3,073,153	1,507,263
Value of overseas exports ($ thousand): 1,565,890		

Table B80 Estimated inter-regional trade in paper products (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	8475	1579	693	72	323	344	407	732	101	62	512	35	156	86	14 105
A	39 917	–	175 077	56 887	4229	20 328	21 936	24 494	43 867	5394	3424	26 605	1793	7799	4238	452 948
WK	4481	105 472	–	18 200	997	5275	5787	6008	9953	1124	727	5430	365	1554	836	172 673
BP	10 164	177 205	94 108	–	3788	14 631	13 178	16 823	27 264	3165	2034	15 384	1035	4436	2393	400 608
G	139	1734	679	499	–	515	175	406	647	76	49	371	25	107	58	5693
HB	2034	27169	11 704	6278	1679	–	3618	11 462	13 665	1247	839	5765	385	1575	831	91 683
T	440	5947	2604	1147	116	734	–	1796	2692	255	170	1184	79	326	172	18 350
MW	1296	16 549	6738	3649	669	5794	4476	–	21 622	1186	856	5111	338	1308	673	72 998
WT	2032	25 866	9742	5161	930	6029	5855	18 871	–	3092	2506	12 097	792	2862	1435	101 051
TN	206	2345	811	442	81	406	408	763	2280	–	820	2405	227	510	245	12 415
M	85	991	349	189	34	182	182	367	1231	546	–	1224	76	220	102	6003
C	2920	32 208	10 911	5979	1094	5222	5289	9159	24 835	6698	5118	–	4086	18 462	6997	144 383
WC	85	936	316	173	32	150	152	261	700	273	138	1761	–	338	151	5678
O	761	8083	2674	1476	271	1222	1245	2006	5030	1215	787	15 805	671	–	5804	48 880
S	297	3103	1016	563	103	456	466	730	1782	413	259	4232	211	4101	–	18 420
Total	64 857	416 084	318 309	101 335	14 095	61 266	63 112	93 554	156 298	24 784	17 789	97 887	10 119	43 753	24 022	1 565 890

Table B81 Estimated exports in petroleum from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	539,139	495,472
Auckland	17,719	16,284
Waikato	0	0
Bay of Plenty	10,159	9,336
Gisborne	0	0
Hawkes Bay	1,914	1,759
Taranaki	7,750	7,122
Manawatu/Wanganui	38	35
Wellington	5,332	4,900
Tasman/Nelson	2,285	2,100
Marlborough	0	0
Canterbury	15,293	14,055
West Coast	60	55
Otago	3,614	3,321
Southland	1,185	1,089
Total	604,488	555,528
Value of overseas exports ($ thousand): 48,960		

Table B82 Estimated inter-regional trade in petroleum (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	309984	57162	26331	2570	11759	12223	14693	26534	3586	2217	18507	1232	5604	3070	43667
A	1364	–	6560	2238	156	766	806	915	1647	199	126	995	66	290	156	1435
WK	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0	0
BP	224	4329	2275	–	90	356	312	405	660	75	48	371	25	107	57	823
G	0	0	0	0	–	0	0	0	0	0	0	0	0	0	0	0
HB	37	546	233	131	33	–	71	227	272	24	16	114	8	31	16	155
T	161	2414	1046	484	46	296	–	719	1084	101	67	475	31	130	68	628
MW	1	8	3	2	0	3	2	–	11	1	0	3	0	1	0	3
WT	93	1316	491	273	46	305	289	947	–	153	124	608	39	143	71	432
TN	33	417	143	82	14	72	70	134	402	–	142	422	39	89	42	185
M	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0	0
C	270	3296	1105	636	109	532	525	924	2520	668	510	–	406	1857	698	1239
WC	1	10	3	2	0	2	2	3	7	3	1	18	–	3	1	5
O	49	578	189	110	19	87	86	141	356	85	55	1116	47	–	404	293
S	17	193	63	36	6	28	28	45	110	25	16	260	13	250	–	96
Total	2249	323090	69273	30324	3091	14205	14415	19152	33603	4919	3322	22889	1905	8506	4584	48960

Table B83 Estimated exports in chemicals from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	41,778	17,256
Auckland	1,593,896	658,332
Waikato	193,213	79,803
Bay of Plenty	149,934	61,928
Gisborne	3,810	1,574
Hawkes Bay	61,358	25,343
Taranaki	232,792	96,151
Manawatu/Wanganui	174,984	72,274
Wellington	504,482	208,368
Tasman/Nelson	25,590	10,570
Marlborough	15,218	6,286
Canterbury	428,865	177,135
West Coast	5,763	2,380
Otago	35,152	14,519
Southland	38,714	15,990
Total	3,505,547	1,447,907
Value of overseas exports ($ thousand): 2,057,640		

Table B84 Estimated inter-regional trade in chemicals (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	10740	2013	925	92	415	423	516	926	128	79	646	44	199	109	24522
A	59353	–	263953	89809	6397	30854	31871	36710	65681	8085	5132	39698	2691	11771	6326	935564
WK	2124	50394	–	9161	481	2553	2681	2871	4751	537	347	2583	175	748	398	113410
BP	1618	28440	15195	–	614	2378	2051	2700	4372	508	326	2458	166	717	383	88006
G	39	495	195	150	–	149	49	116	185	22	14	105	7	31	16	2237
HB	578	7778	3371	1893	485	–	1004	3282	3909	357	240	1643	110	454	237	36015
T	2365	32231	14199	6549	634	4029	–	9736	14576	1380	922	6391	430	1778	931	136641
MW	1320	16989	6959	3946	693	6025	4455	–	22178	1218	879	5225	348	1352	689	102710
WT	4310	55301	20953	11624	2007	13054	12136	40350	–	6611	5359	25751	1695	6162	3056	296114
TN	181	2072	721	411	72	363	350	674	2013	–	725	2116	201	454	216	15020
M	92	1078	382	216	38	200	191	399	1337	594	–	1325	83	241	111	8933
C	3683	40942	13954	8007	1404	6723	6518	11644	31542	8516	6506	–	5201	23635	8860	251729
WC	37	407	138	79	14	66	64	114	305	119	60	763	–	148	65	3383
O	233	2496	831	480	84	382	373	619	1552	375	243	4859	207	–	1785	20633
S	265	2793	920	533	94	415	406	657	1602	372	233	3792	190	3717	–	22724
Total	76199	252157	343784	133783	13109	67606	62572	110388	154927	28822	21066	97357	11549	51407	23182	2057640

Table B85 Estimated exports in non-metallic products from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	52,041	42,206
Auckland	177,547	143,993
Waikato	38,288	31,052
Bay of Plenty	11,180	9,068
Gisborne	9,215	7,474
Hawkes Bay	21,882	17,747
Taranaki	9,303	7,545
Manawatu/Wanganui	13,349	10,826
Wellington	63,474	51,479
Tasman/Nelson	15,385	12,477
Marlborough	3077	2,496
Canterbury	56,817	46,080
West Coast	36,254	29,403
Otago	9386	7612
Southland	11,939	9683
Total	529,139	429,139
Value of overseas exports ($ thousand): 100,000		

Table B86 Estimated inter-regional trade in non-metallic products (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	26373	4875	2251	219	1002	1047	1255	2268	306	190	1578	103	479	262	9835
A	12833	–	57616	19706	1373	6721	7107	8043	14498	1747	1112	8739	569	2556	1374	33554
WK	810	19676	–	3545	182	981	1054	1109	1850	205	133	1003	65	286	152	7236
BP	233	4191	2208	–	88	345	304	394	642	73	47	360	23	104	55	2113
G	184	2370	920	712	–	701	234	549	881	101	65	502	33	145	77	1742
HB	398	5484	2343	1323	332	–	713	2290	2748	246	166	1152	74	314	164	4135
T	183	2548	1107	513	49	313	–	762	1149	106	71	502	32	138	72	1758
MW	194	2560	1034	590	101	893	676	–	3333	179	130	783	50	200	102	2523
WT	1049	13779	5148	2871	485	3201	3046	9950	–	1607	1307	6380	404	1506	747	11996
TN	210	2466	846	485	83	425	419	794	2388	–	844	2505	229	529	252	2907
M	36	431	151	86	15	79	77	158	534	232	–	527	32	95	44	582
C	946	10764	3617	2086	358	1739	1726	3030	8268	2185	1675	–	1307	6094	2286	10738
WC	448	5071	1699	981	168	812	807	1402	3783	1443	731	9452	–	1807	798	6852
O	120	1319	433	252	43	199	199	324	818	194	126	2555	105	–	926	1774
S	158	1708	555	323	56	250	250	398	977	222	139	2306	111	2229	–	2256
Total	17801	98740	82552	35723	3551	17661	17661	30457	44136	8845	6737	38345	3138	16481	7312	100000

Table B87 Estimated exports in basic and fabricated metals from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	55,407	24,655
Auckland	966,966	430,276
Waikato	300,943	133,912
Bay of Plenty	51,123	22,748
Gisborne	9,869	4,391
Hawkes Bay	54,157	24,098
Taranaki	246,526	109,698
Manawatu/Wanganui	92,199	41,026
Wellington	198,712	88,422
Tasman/Nelson	39, 617	17,629
Marlborough	9,628	4,284
Canterbury	189,087	84,139
West Coast	3,525	1,569
Otago	95,623	42,550
Southland	378,014	168,207
Total	2,691,396	1,197,606
Value of overseas exports ($ thousand): 1,493,790		

Table B88 Estimated inter-regional trade in basic and fabricated metals (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	15355	2852	1331	130	593	604	739	1336	181	112	929	63	282	147	30752
A	38802	–	171393	59223	4146	20234	20846	24094	43426	5258	3345	26163	1760	7658	3927	536689
WK	3553	84484	–	15455	798	4283	4486	4821	8037	894	579	4355	292	1245	623	167031
BP	594	10468	5542	–	223	876	753	996	1624	186	119	910	61	262	133	28374
G	110	1382	539	421	–	416	135	324	520	60	39	296	20	85	44	5478
HB	548	7396	3176	1812	456	–	953	3125	3750	337	227	1571	105	429	214	30058
T	2691	36770	16051	7518	716	4599	–	11125	16778	1562	1046	7333	489	2014	1006	136828
MW	746	9628	3908	2251	388	3417	2520	–	12682	685	495	2978	197	761	370	51173
WT	1827	23494	8821	4969	843	5550	5146	17170	–	2787	2264	11003	719	2599	1230	110290
TN	300	3454	1191	690	119	606	582	1126	3385	–	1202	3548	335	751	341	21989
M	62	734	258	148	25	136	130	272	919	401	–	907	57	163	71	5344
C	1751	19509	6588	3839	662	3206	3100	5557	15164	4026	3083	–	2474	11181	3999	104948
WC	24	268	90	53	9	44	42	75	203	78	39	506	–	97	41	1957
O	685	7345	2422	1422	246	1125	1095	1826	4608	1096	712	14382	609	-	4977	53073
S	2784	29380	9591	5647	978	4372	4267	6921	17006	3883	2437	40123	2000	38818	–	209807
Total	54478	249668	232424	104779	9740	49458	44660	78170	129436	21433	15699	115005	9180	66344	17132	1493790

Table B89 Estimated exports in equipment and machinery from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	117,849	49,360
Auckland	1,398,265	585,652
Waikato	384,040	160,852
Bay of Plenty	216,001	90,470
Gisborne	15,238	6,382
Hawkes Bay	113,098	47,370
Taranaki	125,368	52,509
Manawatu/Wanganui	168,907	70,745
Wellington	289,205	121,131
Tasman/Nelson	51,475	21,560
Marlborough	70,856	29,678
Canterbury	930,027	389,534
West Coast	28,495	11,935
Otago	186,331	78,043
Southland	57,827	24,220
Total	4,152,983	1,739,443
Value of overseas exports ($ thousand): 2,413,540		

Table B90 Estimated inter-regional trade in equipment and machinery (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	30 704	5739	2641	263	1191	1244	1478	2692	365	222	1815	126	565	314	68 489
A	52 750	–	233 946	79 727	5692	27 558	29 129	32 682	59 356	7190	4493	34 657	2394	10 394	5683	812 613
WK	4275	101 434	–	18 417	969	5164	5548	5788	9723	1082	688	5107	352	1496	809	223 188
BP	2362	41 511	22 116	–	897	3488	3078	3948	6488	742	469	3524	243	1040	564	125 531
G	159	2006	788	607	–	606	202	470	760	88	56	419	29	124	67	8855
HB	1078	14 508	6270	3527	906	–	1926	6131	7412	666	441	3011	206	842	447	65 728
T	1290	17 583	7724	3568	346	2208	–	5320	8085	753	495	3425	235	964	513	72 859
MW	1285	16 539	6755	3837	675	5894	4460	–	21 952	1186	842	4996	339	1308	677	98 162
WT	2507	32 170	12 155	6754	1169	7631	7259	23 511	–	3848	3071	14 713	987	3561	1797	168 074
TN	369	4229	1468	838	147	745	734	1379	4176	–	1457	4242	411	920	445	29 915
M	432	5085	1796	1020	178	948	929	1884	6412	2803	–	6139	393	1129	528	41 179
C	8073	89 748	30 501	17 529	3082	14 809	14 691	25 566	70 300	18 675	14 047	–	11 412	51 472	19 627	540 493
WC	185	2049	694	399	70	335	333	573	1558	598	297	3771	–	740	332	16 560
O	1256	13 446	4462	2583	456	2068	2065	3343	8500	2022	1290	25 713	1118	—	9720	108 288
S	403	4245	1395	810	143	634	635	1000	2476	566	349	5662	290	5613	–	33 607
Total	76 425	375 257	335 809	142 257	14 994	73 281	72 234	113 072	209 891	40 584	28 219	117 195	18 534	80 166	41 526	2413 540

Table B91 Estimated exports in services from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	1,295,288	845,767
Auckland	13,957,038	9,113,345
Waikato	2,663,349	1,739,052
Bay of Plenty	1,905,358	1,244,116
Gisborne	413,350	269,900
Hawkes Bay	1,342,952	876,890
Taranaki	2,669,055	1,742,778
Manawatu/Wanganui	1,795,912	1,172,653
Wellington	5,499,842	3,591,160
Tasman/Nelson	881,152	575,354
Marlborough	542,889	354,483
Canterbury	4,266,058	2,785,552
West Coast	459,938	300,320
Otago	2,048,693	1,337,708
Southland	1,198,339	782,464
Total	40,939,212	26,731,542
Value of overseas exports ($ thousand): 14,207,670		

Table B92 Estimated inter-regional trade in services (in thousands of dollars).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Z**
N	–	205 129	110 577	57 629	10 924	45 208	43 832	52 510	50 102	25 019	16 558	122 978	11 751	50 151	43 399	449 521
A	530 320	–	1 481 472	772 087	146 352	605 684	587 250	703 514	671 245	335 191	221 838	1 647 619	157 430	671 901	581 443	4 843 693
WK	88 848	460 431	–	129 353	24 519	101 474	98 386	117 865	112 458	56 157	37 166	276 037	26 375	112 568	97 413	924 297
BP	59 496	308 321	166 204	–	16 419	67 951	65 883	78 926	75 306	37 605	24 888	184 844	17 662	75 380	65 231	661 241
G	12 218	63 315	34 131	17 788	–	13 954	13 529	16 208	15 464	7722	5111	37 958	3627	15 479	13 395	143 450
HB	41 315	214 101	115 414	60 149	11 402	–	45 750	54 807	52 293	26 113	17 282	128 358	12 265	52 344	45 297	466 062
T	81 976	424 820	229 005	119 349	22 623	93 626	–	108 749	103 760	51 814	34 292	254 688	24 335	103 862	89 879	926 277
MW	55 734	288 825	155 695	81 142	15 381	63 654	61 717	–	70 544	35 227	23 314	173 156	16 545	70 613	61 107	623 259
WT	170 188	881 954	475 428	247 775	46 967	194 374	188 458	225 769	–	107 568	71 192	528 747	50 522	215 624	186 594	1 908 682
TN	26 472	137 182	73 950	38 540	7305	30 233	29 313	35 117	33 506	–	11 073	82 243	7858	33 539	29 023	305 798
M	16 151	83 696	45 118	23 514	4457	18 446	17 884	21 425	20 442	10 208	–	50 177	4794	20 462	17 708	188 406
C	144 629	749 499	404 027	210 564	39 913	165 182	160 155	191 862	183 062	91 413	60 500	–	42 934	183 241	158 571	1 480 506
WC	13 608	70 518	38 013	19 811	3755	15 541	15 068	18 052	17 224	8601	5692	42 277	–	17 240	14 919	159 618
O	63 399	328 547	177 108	92 302	17 496	72 409	70 205	84 104	80 246	40 072	26 520	196 970	18 821	-	69 511	710 985
S	36 786	190 636	102 765	53 557	10 152	42 014	40 735	48 800	46 562	23 251	15 388	144 290	10 920	46 607	–	415 875
Total	1 341 139	4 406 974	3608906	1 923 558	377 665	1 529 751	1 438 165	1 757 708	1 532 215	855 960	570 815	3 840 342	405 840	1 669 012	1 473 491	14 207 670

Table B93 Estimated exports in all industries from all regions.

Region	Total exports ($thousand)	Domestic exports ($thousand)
Northland	3,632,027	2,106,619
Auckland	22,828,296	12,906,665
Waikato	8,357,015	4,242,115
Bay of Plenty	4,957,741	2,496,760
Gisborne	1,171,623	660,506
Hawkes Bay	3,875,712	1,865,035
Taranaki	5,129,004	2,475,277
Manawatu/Wanganui	4,376,890	2,332,020
Wellington	7,860,058	4,712,156
Tasman/Nelson	2,240,039	1,186,863
Marlborough	1,569,632	812,129
Canterbury	9,749,171	4,902,302
West Coast	1,201,380	628,082
Otago	4,487,426	2,200,012
Southland	3,511,714	1,490,745
Total	84,947,729	45,017,289
Value of overseas exports ($ thousand): 39,930,440		

Table B94 Estimated imports in all industries into all regions.

Region	Total imports ($thousand)	Overseas imports ($thousand)
Northland	3,568,864	1,606,000
Auckland	21,300,153	11,610,804
Waikato	7,515,546	1,101,403
Bay of Plenty	4,644,869	1,373,030
Gisborne	1,043,571	519,265
Hawkes Bay	3,360,160	1,108,924
Taranaki	3,819,027	1,692,176
Manawatu/Wanganui	4,255,983	1,378,868
Wellington	9,210,995	5,495,473
Tasman/Nelson	2,039,814	825,587
Marlborough	1,261,888	433,895
Canterbury	9,009,077	3,618,309
West Coast	865,743	310,981
Otago	4,121,190	1,741,316
Southland	2,920,708	1,104,266
Total	78,937,587	33,920,298

Table B95 Estimated inter-regional trade in all industries (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Z
N	–	998 942	252 977	124 288	17 366	74 889	74 339	89 413	118 112	34 092	22 137	169 930	14 822	64 281	51 031	1 525 408
A	872 211	–	2 998 938	1 288 835	182 498	781 396	773 448	915 181	1 056 439	380 798	250 481	1 876 904	172 768	739 213	617 556	9 921 630
WK	152 232	2 063 423	–	410 507	38 805	179 124	179 213	204 316	262 607	72 543	47 638	356 091	31 499	135 066	109 052	4 114 900
BP	91 770	891 117	467 971	–	28 416	115 137	107 634	132 975	164 789	47 667	31 316	234 576	20 945	89 637	72 811	2 460 981
G	21 687	190 081	80 871	54 787	–	49 782	25 502	44 272	62 414	12 917	8390	64 219	5326	22 943	17 314	511 118
HB	63 693	521 197	245 996	133 374	29 450	–	85 390	181 349	206 949	39 376	26 018	192 014	16 478	69 527	54 223	2 010 676
T	99 612	674 179	334 449	169 033	27 391	123 946	–	182 136	216 674	62 187	41 155	303 293	27 497	117 094	96 633	2 653 726
MW	76 221	568 029	262 739	143 911	25 995	157 524	131 591	–	433 043	54 353	36 917	256 685	21 886	91 601	71 524	2 044 870
WT	193 087	1 186 328	586 160	310 307	57 487	263 771	253 851	440 660	–	142 722	99 399	668 027	59 446	248 329	202 582	3 147 903
TN	36 872	259 480	115 513	62 289	11 231	50 432	49 901	73 931	152 797	–	49 682	204 874	19 221	59 316	41 322	1 053 176
M	22 807	163 566	72 957	39 296	7073	32 462	32 118	50 414	119 974	50 726	–	146 684	10 721	37 681	25 651	757 503
C	188 449	1 247 186	569 770	306 202	56 277	243 798	238 831	330 393	567 937	190 710	135 236	–	104 120	461 116	262 278	4 846 869
WC	18 564	127 737	56 621	30 717	5619	24 554	23 904	33 572	59 849	24 597	13 699	147 804	–	37 192	23 653	573 297
O	77 148	480 743	225 899	120 926	22 409	94 473	92 415	120 639	174 744	61 975	40 469	486 555	30 805	–	170 812	2 287 413
S	48 510	317 340	143 282	77 368	14 288	59 950	58 713	77 864	119 193	39 563	25 456	283 113	19 229	206 877	–	2 020 968
Total	1 962 864	9 689 349	6 414 143	3 271 840	524 305	2 251 236	2 126 851	2 877 115	3 715 521	1 214 227	827 993	5 390 768	554 762	2 379 873	1 816 442	39 930 446

Table B96 Estimated value of goods requiring inter-regional transport only within New Zealand across all industries (in thousands of dollars).

Origin	Destination															
	N	A	WK	BP	G	HB	T	MW	WT	TN	M	C	WC	O	S	Total
N	–	793 813	142 399	66 660	6442	29 681	30 507	36 902	68 010	9073	5579	46 951	3071	14 130	7632	1 260 852
A	341 891	–	1 517 466	516 749	36 146	175 712	186 199	211 668	385 194	45 607	28 642	229 285	15 337	67 312	36 113	3 973 320
WK	63 384	1 602 991	–	281 153	14 285	77 649	80 827	86 451	150 148	16 387	10 472	80 054	5123	22 498	11 639	2 503 063
BP	32 274	582 796	301 767	–	11 997	47 186	41 751	54 049	89 483	10 063	6428	49 731	3283	14 257	7580	1 252 644
G	9469	126 766	46 741	36 999	–	35 828	11 973	28 065	46 950	5195	3279	26 261	1699	7463	3918	390 606
HB	22 379	307 096	130 582	73 225	18 049	–	39 641	126 541	154 656	13 263	8735	63 657	4214	17 182	8926	988 145
T	17 635	249 359	105 444	49 684	4768	30 320	–	73 387	112 913	10 373	6863	48 605	3161	13 232	6754	732 500
MW	20 488	279 204	107 044	62 769	10 614	93 870	69 874	–	362 498	19 127	13 603	83 529	5341	20 988	10 418	1 159 367
WT	22 899	304 375	110 731	62 531	10 520	69 397	65 393	214 891	–	35 154	28 208	139 280	8924	32 705	15 987	1 120 996
TN	10 401	122 299	41 563	23 750	3926	20 199	20 588	38 815	119 291	–	38 609	122 631	11 363	25 777	12 298	611 509
M	6657	79 870	27 839	15 782	2616	14 016	14 234	28 989	99 531	40 518	–	96 506	5927	17 219	7944	457 646
C	43 820	497 687	165 743	95 638	16 364	78 616	78 677	138 530	384 875	99 296	74 736	–	61 185	277 875	103 707	2 116 750
WC	4956	57 219	18 608	10 906	1864	9012	8835	15 521	42 626	15 996	8006	105 527	–	19 951	8734	327 763
O	13 749	152 195	48 792	28 624	4913	22 064	22 210	36 535	94 498	21 904	13 949	289 585	11 985	–	1001 302	862 304
S	11 724	126 705	40 518	23 811	4136	17 935	17 978	29 064	72 631	16 312	10 068	168 823	8308	160 269	–	708 282
Total	621 724	5 282 375	2 805 236	1 348 282	146 640	721 485	688 686	1 119 408	2 183 306	358 267	257 178	1 550 426	148 922	710 861	342 951	18 285 747

B3.7 Conversion of dollar values into trade flows

The trade flows are given in terms of weight (thousand tonnes), using the industry mean output prices from block A (Chapter B3.2).

Table B97 Inter-regional trade flows in horticulture (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	18.083	3.301	1.482	0.140	0.661	0.711	0.843	1.551	0.203	0.125	1.067	0.072	0.325	0.178	28.743
A	4.196	–	18.971	6.308	0.426	2.157	2.348	2.626	4.822	0.564	0.357	2.872	0.192	0.842	0.454	47.136
WK	0.592	14.651	–	2.535	0.126	0.703	0.778	0.809	1.374	0.148	0.095	0.736	0.049	0.211	0.112	22.920
BP	2.479	45.470	23.661	–	0.885	3.602	3.273	4.185	6.953	0.768	0.492	3.854	0.258	1.112	0.595	97.585
G	0.712	9.343	3.584	2.694	–	2.662	0.915	2.120	3.463	0.387	0.248	1.950	0.130	0.564	0.302	29.075
HB	1.047	14.718	6.213	3.410	0.828	–	1.897	6.020	7.357	0.639	0.429	3.049	0.202	0.833	0.436	47.078
T	0.049	0.704	0.302	0.136	0.012	0.083	–	0.206	0.317	0.028	0.019	0.137	0.009	0.038	0.020	2.061
MW	0.510	6.854	2.734	1.515	0.252	2.302	1.795	–	8.901	0.464	0.334	2.097	0.136	0.529	0.270	28.665
WT	0.219	2.936	1.083	0.587	0.096	0.656	0.643	2.076	–	0.332	0.268	1.340	0.087	0.317	0.158	10.800
TN	0.509	6.092	2.065	1.150	0.191	1.011	1.027	1.922	5.886	–	2.010	6.100	0.573	1.293	0.617	30.446
M	0.182	2.230	0.769	0.426	0.070	0.392	0.396	0.800	2.751	1.616	–	2.687	0.167	0.483	0.223	12.736
C	1.181	13.703	4.548	2.550	0.424	2.131	2.178	3.778	10.501	2.694	2.054	–	1.687	7.671	2.882	57.983
WC	0.004	0.047	0.016	0.009	0.001	0.007	0.007	0.013	0.035	0.013	0.007	0.087	–	0.017	0.007	0.270
O	0.096	1.076	0.349	0.197	0.033	0.156	0.161	0.259	0.66	0.153	0.099	2.054	0.087	–	0.748	6.133
S	0.003	0.028	0.009	0.005	0.001	0.004	0.004	0.006	0.016	0.003	0.002	0.037	0.002	0.036	–	0.155
Total	11.778	135.935	67.606	23.005	3.484	16.529	16.134	25.664	54.592	7.559	6.540	28.036	3.651	14.271	7.002	421.787

Note: horticulture is calculated to be worth $1,400 per tonne.

Table B98 Inter-regional trade flows in pastoral agriculture (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	53.854	8.735	4.390	0.406	1.916	1.893	2.301	4.564	0.602	0.365	3.088	0.194	0.905	0.466	83.677
A	6.473	–	28.132	10.472	0.693	3.501	3.502	4.020	7.950	0.937	0.583	4.659	0.291	1.315	0.666	73.194
WK	9.207	246.728	–	42.459	2.071	11.514	11.707	12.494	22.858	2.475	1.567	12.050	0.751	3.321	1.664	380.865
BP	1.326	26.321	12.167	–	0.500	2.028	1.693	2.221	3.976	0.442	0.279	2.168	0.135	0.602	0.302	54.159
G	1.394	19.799	6.747	5.679	–	5.487	1.732	4.120	7.250	0.817	0.513	4.016	0.251	1.119	0.563	59.486
HB	0.421	6.399	2.399	1.474	0.351	–	0.737	2.400	3.160	0.276	0.182	1.288	0.080	0.339	0.167	19.673
T	0.439	6.764	2.578	1.301	0.117	0.779	–	1.816	3.006	0.272	0.178	1.278	0.079	0.338	0.167	19.112
MW	2.968	43.138	15.289	9.485	1.548	14.092	10.091	–	55.335	2.909	2.057	12.641	0.776	3.113	1.493	174.934
WT	2.003	29.026	9.516	5.775	0.927	6.312	5.682	18.826	–	3.265	2.593	12.878	0.782	2.933	1.370	101.886
TN	0.479	6.207	1.869	1.166	0.189	1.002	0.934	1.796	5.923	–	2.001	6.039	0.529	1.232	0.553	29.919
M	0.144	1.920	0.588	0.365	0.059	0.328	0.304	0.631	2.339	0.995	–	2.248	0.130	0.389	0.169	10.611
C	1.244	15.624	4.607	2.892	0.471	2.363	2.219	3.950	11.828	3.057	2.289	–	1.744	8.179	2.888	63.357
WC	0.232	2.903	0.853	0.536	0.087	0.435	0.409	0.721	2.134	0.796	0.394	5.183	–	0.956	0.398	16.039
O	0.569	6.880	1.981	1.253	0.205	0.970	0.917	1.518	4.203	0.973	0.618	12.763	0.502	–	4.204	37.557
S	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000
Total	26.901	465.561	95.462	87.248	7.625	50.727	41.819	56.813	134.524	17.818	13.619	80.299	6.246	24.739	15.068	1124.47

Note: pastoral agriculture is calculated to be worth $2,500 per tonne.

Table B99 Inter-regional trade flows in forestry (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	210.113	37.596	17.361	1.611	7.822	8.278	9.841	17.947	2.355	1.463	12.513	0.809	3.759	2.064	333.530
A	8.524	–	38.395	13.132	0.872	4.533	4.857	5.451	9.913	1.163	0.741	5.987	0.385	1.732	0.935	96.621
WK	14.237	358.387	–	62.514	3.061	17.504	19.064	19.894	33.465	3.606	2.339	18.181	1.166	5.137	2.746	561.300
BP	4.925	91.820	46.828	–	1.773	7.403	6.621	8.495	13.979	1.548	0.998	7.855	0.504	2.235	1.199	196.183
G	5.607	74.827	28.132	21.754	–	21.703	7.338	17.070	27.617	3.097	1.992	15.765	1.013	4.502	2.417	232.833
HB	3.750	53.566	22.160	12.511	2.990	–	6.916	22.022	26.659	2.321	1.567	11.200	0.714	3.021	1.584	170.982
T	0.398	5.751	2.418	1.121	0.101	0.693	–	1.693	2.576	0.232	1.156	1.129	0.072	0.306	0.161	16.808
MW	1.673	22.837	8.929	5.090	0.834	7.808	5.989	–	29.526	1.545	1.119	6.951	0.439	1.755	0.898	95.392
WT	1.840	25.057	9.062	5.054	0.814	5.703	5.499	17.814	–	2.827	2.301	11.547	0.721	2.696	1.343	92.279
TN	2.342	28.503	9.469	5.427	0.885	4.815	4.811	9.039	27.414	–	9.445	28.808	2.598	6.024	2.882	142.461
M	1.234	15.411	5.212	2.970	0.483	2.758	2.738	5.555	18.929	8.014	–	18.748	1.118	3.325	1.537	88.032
C	2.068	24.385	7.933	4.576	0.749	3.860	3.882	6.758	18.606	4.787	3.671	–	2.910	13.594	5.119	102.897
WC	0.778	9.136	2.963	1.711	0.280	1.433	1.443	2.486	6.769	2.514	1.275	16.945	–	3.206	1.421	52.361
O	0.732	8.311	2.640	1.534	0.252	1.226	1.242	2.010	5.117	1.179	0.767	16.014	0.649	–	5.767	47.440
S	0.127	1.417	0.446	0.260	0.043	0.203	0.206	0.325	0.805	0.178	0.112	1.904	0.091	1.821	–	7.938
Total	48.234	929.520	222.183	155.014	14.747	87.465	78.884	128.452	239.321	35.367	27.946	173.547	13.189	53.113	30.074	2237.056

Note: forestry is calculated to be worth $270 per tonne.

Table B100 Inter-regional trade flows in fishing (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	6.038	1.111	0.512	0.050	0.229	0.238	0.286	0.517	0.066	0.040	0.360	0.024	0.109	0.059	9.639
A	1.137	–	5.130	1.753	0.122	0.600	0.633	0.718	1.292	0.148	0.092	0.779	0.051	0.227	0.121	12.802
WK	0.216	5.301	–	0.9494	0.049	0.264	0.283	0.298	0.496	0.052	0.033	0.269	0.018	0.077	0.040	8.345
BP	0.034	0.614	0.322	–	0.013	0.050	0.044	0.058	0.094	0.010	0.006	0.053	0.003	0.015	0.008	1.324
G	0.034	0.444	0.172	0.133	–	0.131	0.044	0.103	0.164	0.018	0.011	0.094	0.006	0.027	0.014	1.394
HB	0.032	0.444	0.189	0.106	0.027	–	0.057	0.185	0.221	0.019	0.012	0.093	0.006	0.025	0.013	1.429
T	0.027	0.380	0.164	0.076	0.007	0.047	–	0.113	0.171	0.015	0.010	0.075	0.005	0.020	0.011	1.120
MW	0.011	0.143	0.057	0.033	0.006	0.050	0.038	–	0.185	0.009	0.007	0.043	0.003	0.011	0.006	0.600
WT	0.070	0.928	0.345	0.192	0.032	0.215	0.204	0.669	–	0.102	0.082	0.428	0.027	0.101	0.050	3.446
TN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000	0.000
M	0.171	2.076	0.722	0.411	0.070	0.378	0.370	0.758	2.557	1.055	–	2.527	0.154	0.452	0.206	11.907
C	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000
WC	0.014	0.155	0.052	0.030	0.005	0.025	0.024	0.043	0.115	0.042	0.021	0.287	–	0.055	0.024	0.889
O	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000	0.000
S	0.080	0.870	0.281	0.164	0.028	0.127	0.127	0.202	0.496	0.107	0.066	1.170	0.057	1.130	–	4.904
Total	1.825	17.393	8.544	4.358	0.407	2.116	2.062	3.432	6.318	1.642	0.381	6.176	0.353	2.250	0.552	57.799

Note: fishing is calculated to be worth $5,630 per tonne.

Table B101 Inter-regional trade flows in mining (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	401.867	73.040	34.114	3.331	15.204	15.842	19.023	34.411	4.640	2.847	23.999	1.418	7.192	3.948	640.875
A	52.469	–	233.595	80.810	5.647	27.593	29.107	32.997	59.521	7.175	4.516	35.961	2.115	10.379	5.602	587.486
WK	52.224	1279.225	–	229.249	11.810	63.497	68.083	71.766	119.746	13.259	8.495	65.076	3.816	18.341	9.800	2014.389
BP	4.677	84.862	43.962	–	1.771	6.953	6.122	7.935	12.952	1.474	0.939	7.280	0.427	2.067	1.108	182.530
G	0.201	2.610	0.997	0.780	–	0.769	0.256	0.602	0.966	0.111	0.071	0.551	0.032	0.157	0.084	8.188
HB	5.419	75.323	31.652	18.074	4.544	–	9.731	31.297	37.580	3.363	2.242	15.794	0.921	4.249	2.228	242.414
T	0.131	1.850	0.790	0.371	0.065	0.227	–	0.550	0.831	0.077	0.051	0.364	0.021	0.099	0.052	5.450
MW	2.708	35.982	14.291	8.240	1.420	12.502	9.442	–	46.637	2.507	1.794	10.983	0.634	2.766	1.415	151.322
WT	4.625	61.274	22.511	12.697	2.151	14.172	13.454	44.027	–	7.122	5.724	28.317	1.617	6.595	3.285	227.571
TN	1.931	22.863	7.715	4.472	0.767	3.925	3.861	7.328	22.045	–	7.709	23.173	1.911	4.834	2.312	114.846
M	3.358	40.796	14.015	8.078	1.382	7.419	7.253	14.861	50.235	21.855	–	49.769	2.714	8.805	4.069	234.610
C	3.883	44.567	14.727	8.592	1.479	7.170	7.099	12.482	34.090	9.012	6.827	–	4.876	24.854	9.356	189.014
WC	26.849	306.715	101.052	59.008	10.160	48.903	48.459	84.366	227.816	86.956	43.558	570.500	–	107.672	47.707	1769.721
O	15.284	168.935	54.514	32.035	5.533	25.335	25.251	41.288	104.279	24.690	15.864	326.420	12.087	–	117.231	968.744
S	3.583	38.944	12.440	7.333	1.268	5.673	5.669	9.020	22.182	5.043	3.131	52.483	2.287	50.069	–	219.127
Total	177.343	2565.814	625.302	503.851	51.299	239.345	249.628	377.540	773.291	187.282	103.768	1210.670	34.879	248.077	208.197	7556. 287

Note: mining is calculated to be worth $70 per tonne.

Table B102 Inter-regional trade flows in meat processing (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	4.527	0.808	0.380	0.037	0.155	0.169	0.206	0.386	0.052	0.031	0.261	0.018	0.075	0.038	7.142
A	0.485	–	2.141	0.746	0.053	0.234	0.258	0.296	0.553	0.067	0.041	0.324	0.022	0.090	0.045	5.352
WK	0.627	15.532	–	2.750	0.143	0.699	0.784	0.837	1.446	0.160	0.100	0.762	0.051	0.206	0.102	24.200
BP	0.186	3.405	1.731	–	0.071	0.253	0.233	0.306	0.517	0.059	0.037	0.282	0.019	0.077	0.038	7.212
G	0.026	0.344	0.129	0.101	–	0.092	0.032	0.076	0.126	0.015	0.009	0.070	0.005	0.019	0.009	1.054
HB	0.745	10.466	4.317	2.481	0.629	–	1.282	4.177	5.193	0.465	0.303	2.117	0.141	0.546	0.264	33.125
T	0.488	6.939	2.909	1.373	0.132	0.770	–	1.983	3.099	0.288	0.186	1.317	0.088	0.342	0.166	20.079
MW	0.314	4.214	1.643	0.953	0.166	1.327	1.048	–	5.432	0.292	0.204	1.241	0.082	0.299	0.142	17.358
WT	0.147	1.967	0.709	0.403	0.069	0.412	0.409	1.358	–	0.228	0.178	0.877	0.057	0.496	0.090	7.101
TN	0.028	0.332	0.110	0.064	0.011	0.052	0.053	0.102	0.319	–	0.109	0.325	0.031	0.065	0.029	1.630
C	0.068	0.841	0.284	0.165	0.028	0.139	0.142	0.294	1.030	0.449	0.000	0.990	0.062	0.168	0.072	4.730
WC	0.741	8.591	2.786	1.636	0.284	1.253	1.297	2.311	6.535	1.729	1.278	–	1.038	4.427	1.540	35.446
O	0.029	0.332	0.107	0.063	0.011	0.048	0.050	0.088	0.245	0.094	0.046	8.596	–	0.108	0.044	1.860
S	0.626	6.989	2.214	1.309	0.228	0.950	0.990	1.641	4.291	1.017	0.637	13.028	0.552	–	4.142	38.615
Total	0.776	8.525	2.673	1.586	0.276	1.125	1.176	1.896	4.829	1.099	0.666	11.083	0.553	10.127	–	46.391

Note: meat processing is calculated to be worth $5.020 per tonne.

Table B103 Inter-regional trade flows in dairy processing (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	13.573	2.360	1.132	0.114	0.523	0.476	0.632	1.177	0.156	0.096	0.800	0.050	0.242	0.129	21.459
A	4.728	–	20.905	7.427	0.536	2.630	2.423	3.036	5.637	0.669	0.421	3.321	0.207	0.966	0.505	53.411
WK	1.846	46.950	–	8.267	0.440	2.374	2.223	2.591	4.449	0.485	0.311	2.358	0.146	0.669	0.347	73.457
BP	0.444	8.364	4.145	–	0.177	0.698	0.537	0.769	1.292	0.145	0.092	0.708	0.044	0.203	0.105	17.725
G	0.006	0.076	0.028	0.022	–	0.023	0.007	0.017	0.028	0.003	0.002	0.016	0.001	0.005	0.002	0.236
HB	0.013	0.185	0.075	0.044	0.011	–	0.021	0.076	0.094	0.008	0.006	0.038	0.002	0.010	0.005	0.589
T	1.282	18.722	7.650	3.684	0.362	2.336	–	5.478	8.510	0.776	0.515	3.637	0.225	0.992	0.506	54.675
MW	0.324	4.472	1.699	1.006	0.179	1.583	1.044	–	5.868	0.310	0.222	1.348	0.082	0.342	0.170	18.651
WT	0.107	1.472	0.517	0.300	0.052	0.347	0.288	1.040	–	0.170	0.137	0.672	0.041	0.158	0.076	5.376
TN	0.070	0.855	0.276	0.164	0.029	0.149	0.128	0.269	0.834	–	0.288	0.855	0.075	0.180	0.083	4.256
M	0.048	0.602	0.198	0.117	0.021	0.112	0.095	0.216	0.750	0.321	–	0.725	0.042	0.129	0.058	3.433
C	0.773	9.216	2.913	1.746	0.311	1.510	1.306	2.539	7.136	1.856	1.409	–	1.054	5.111	1.865	38.746
WC	0.130	1.538	0.485	0.291	0.052	0.250	0.216	0.416	1.157	0.435	0.218	2.825	–	0.537	0.231	8.780
O	0.256	2.937	0.907	0.547	0.098	0.449	0.391	0.706	1.836	0.428	0.275	5.603	0.220	–	1.965	16.617
S	0.302	3.406	1.041	0.630	0.113	0.505	0.441	0.776	1.964	0.439	0.273	4.531	0.209	4.354	–	18.985
Total	10.328	112.368	43.199	25.377	2.496	13.489	9.596	18.563	40.733	6.202	4.266	27.437	2.398	13.897	6.047	336.396

Note: dairy processing is calculated to be worth $3,820 per tonne.

Table B104 Inter-regional trade flows in other food, beverage and tobacco (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	6.329	1.199	0.542	0.050	0.225	0.256	0.302	0.555	0.066	0.039	0.375	0.025	0.144	0.064	10.142
A	34.243	–	152.905	51.192	3.364	16.299	18.787	20.909	38.256	4.084	2.486	22.414	1.510	6.550	3.598	376.596
WK	0.730	17.212	–	3.111	0.151	0.803	0.941	0.974	1.649	0.162	0.100	0.869	0.058	0.248	0.135	27.143
BP	1.400	24.442	13.195	–	0.484	1.883	1.812	2.306	3.817	0.385	0.237	2.081	0.140	0.598	0.326	53.105
G	1.048	13.101	5.214	3.947	–	3.632	1.321	3.047	4.960	0.506	0.311	2.747	0.185	0.792	0.433	41.243
HB	4.221	56.464	24.726	13.665	3.231	–	7.496	23.668	28.827	2.285	1.473	11.748	0.784	3.200	1.707	183.495
T	0.493	6.675	2.971	1.348	0.121	0.769	–	2.003	3.067	0.252	0.161	1.303	0.087	0.357	0.191	19.798
MW	1.014	12.963	5.365	2.994	0.485	4.236	3.495	–	17.193	0.819	0.566	3.926	0.260	1.001	0.521	54.838
WT	1.135	14.471	5.540	3.024	0.482	3.148	3.265	10.490	–	1.524	1.185	6.636	0.434	1.565	0.793	53.692
TN	2.760	31.461	11.064	6.207	1.001	5.080	5.460	10.172	31.042	–	9.298	31.642	2.989	6.683	3.253	158.112
M	1.694	19.802	7.089	3.954	0.636	3.387	3.617	7.277	24.951	9.614	–	23.971	1.497	4.294	2.020	113.803
C	4.966	54.854	18.890	10.665	1.726	8.299	8.979	15.498	42.935	10.053	7.366	–	6.820	30.734	11.774	233.560
WC	0.222	2.445	0.839	0.474	0.077	0.367	0.397	0.678	1.858	0.628	0.304	4.513	–	0.862	0.389	14.055
O	1.201	12.778	4.297	2.444	0.397	1.802	1.963	3.151	8.071	1.693	1.052	24.500	1.039	–	9.066	73.453
S	0.535	5.599	1.864	1.063	0.173	0.767	0.838	1.308	3.264	0.657	0.395	7.488	0.374	7.233	–	31.558
Total	55.662	278.596	255.160	104.630	12.378	50.696	58.626	101.783	210.445	32.727	24.975	144.213	16.202	64.231	34.270	1444.594

Note: 'other food, tobacco and tobacco' is calculated to be worth $1,850 per tonne.

Table B105 Inter-regional trade flows in textiles (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	0.578	0.107	0.050	0.005	0.022	0.023	0.027	0.050	0.007	0.004	0.034	0.002	0.010	0.006	0.924
A	1.884	–	8.413	2.873	0.200	0.962	1.036	1.148	2.108	0.255	0.162	1.254	0.085	0.368	0.200	20.947
WK	0.047	1.134	–	0.205	0.011	0.056	0.061	0.063	0.107	0.012	0.008	0.057	0.004	0.016	0.009	1.788
BP	0.030	0.538	0.285	–	0.011	0.044	0.039	0.050	0.083	0.009	0.006	0.046	0.003	0.013	0.007	1.165
G	0.022	0.278	0.109	0.084	-	0.081	0.028	0.063	0.104	0.012	0.008	0.058	0.004	0.017	0.009	0.877
HB	0.220	2.995	1.287	0.726	0.181	–	0.391	1.230	1.503	0.135	0.091	0.622	0.042	0.170	0.090	9.682
T	0.021	0.296	0.129	0.060	0.006	0.036	–	0.087	0.134	0.012	0.008	0.058	0.004	0.016	0.008	0.875
MW	0.207	2.701	1.097	0.625	0.107	0.929	0.716	–	3.522	0.190	0.137	0.816	0.054	0.209	0.107	11.419
WT	0.073	0.951	0.375	0.199	0.034	0.218	0.211	0.675	–	0.112	0.090	0.435	0.029	0.103	0.052	3.538
TN	0.014	0.158	0.055	0.031	0.005	0.027	0.027	0.050	0.153	–	0.054	0.159	0.015	0.034	0.016	0.797
M	0.005	0.061	0.021	0.012	0.002	0.011	0.011	0.022	0.075	0.033	–	0.073	0.005	0.013	0.006	0.350
C	0.480	5.397	1.824	1.051	0.180	0.860	0.869	1.493	4.153	1.102	0.842	–	0.673	3.029	1.147	23.099
WC	0.001	0.012	0.004	0.002	0.000	0.002	0.002	0.003	0.009	0.003	0.002	0.022	–	0.004	0.002	0.068
O	0.114	1.234	0.407	0.236	0.041	0.183	0.186	0.298	0.766	0.182	0.118	2.361	0.101	–	0.866	7.093
S	0.045	0.478	0.156	0.091	0.016	0.069	0.070	0.109	0.274	0.063	0.039	0.638	0.032	0.619	–	2.700
Total	3.164	16.810	14.253	6.244	0.798	3.498	3.671	5.318	13.040	2.127	1.569	6.633	1.051	4.622	2.525	85.322

Note: textiles are calculated to be worth $7,460 per tonne.

Table B106 Inter-regional trade flows in wood products (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	8.316	1.502	0.686	0.068	0.315	0.326	0.391	0.711	0.093	0.059	0.494	0.032	0.149	0.081	13.223
A	1.657	–	7.367	2.490	0.176	0.876	0.919	1.041	1.886	0.221	0.143	1.135	0.073	0.330	0.177	18.491
WK	1.341	33.003	–	5.744	0.299	1.638	1.748	1.840	3.085	0.333	0.219	1.670	0.107	0.474	0.251	51.753
BP	1.096	19.973	10.285	–	0.410	1.637	1.434	1.856	3.044	0.337	0.221	1.704	0.110	0.487	0.259	42.853
G	0.139	1.819	0.691	0.528	–	0.536	0.178	0.417	0.672	0.075	0.049	0.382	0.025	0.110	0.058	5.681
HB	0.139	1.946	0.813	0.453	0.115	–	0.250	0.803	0.969	0.085	0.058	0.406	0.026	0.110	0.057	6.230
T	0.239	3.374	1.433	0.656	0.063	0.413	–	0.998	1.513	0.137	0.093	0.660	0.042	0.180	0.094	9.895
MW	0.209	2.785	1.100	0.619	0.108	0.968	0.727	–	3.615	0.189	0.139	0.846	0.054	0.214	0.109	11.672
WT	0.278	3.697	1.350	0.744	0.128	0.855	0.808	2.640	–	0.418	0.346	1.699	0.106	0.398	0.197	13.663
TN	0.296	3.524	1.182	0.669	0.116	0.605	0.592	1.123	3.394	–	1.190	3.553	0.321	0.746	0.354	17.666
M	0.039	0.481	0.164	0.092	0.016	0.087	0.085	0.174	0.591	0.251	–	0.584	0.035	0.104	0.048	2.752
C	0.418	4.819	1.583	0.902	0.157	0.775	0.764	1.341	3.681	0.948	0.739	–	0.575	2.691	1.005	20.399
WC	0.133	1.531	0.501	0.286	0.050	0.244	0.241	0.418	1.135	0.422	0.218	2.832	–	0.538	0.237	8.785
O	0.230	2.555	0.820	0.471	0.082	0.383	0.380	0.621	1.575	0.363	0.240	4.911	0.199	–	1.762	14.592
S	0.251	2.739	0.870	0.501	0.088	0.399	0.397	0.631	1.558	0.345	0.221	3.672	0.175	3.527	–	15.374
Total	6.464	90.561	29.660	14.842	1.876	9.733	8.848	14.295	27.420	4.218	3.935	24.548	1.880	10.059	4.689	253.030

Note: wood products are calculated to be worth $2,740 per tonne.

Table B107 Inter-regional trade flows in paper products (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	7.775	1.449	0.636	0.066	0.296	0.316	0.374	0.671	0.092	0.057	0.470	0.032	0.143	0.079	12.456
A	36.621	–	160.621	52.190	3.879	18.650	20.125	22.472	40.245	4.949	3.142	24.408	1.645	7.155	3.888	399.991
WK	4.111	96.763	–	16.697	0.915	4.840	5.309	5.512	9.131	1.031	0.667	4.981	0.335	1.426	0.767	152.485
BP	9.324	162.574	86.338	–	3.475	13.423	12.090	15.434	25.013	2.903	1.866	14.114	0.949	4.070	2.196	353.770
G	0.127	1.591	0.623	0.458	–	0.473	0.161	0.372	0.593	0.070	0.045	0.340	0.023	0.098	0.053	5.028
HB	1.866	24.926	10.738	5.759	1.540	–	3.319	10.516	12.536	1.144	0.769	5.289	0.353	1.445	0.763	80.964
T	0.403	5.456	2.389	1.052	0.106	0.673	–	1.648	2.470	0.234	0.156	1.087	0.073	0.299	0.158	16.205
MW	1.189	15.182	6.181	3.348	0.614	5.316	4.107	–	19.837	01.088	0.785	4.689	0.310	1.200	0.618	64.463
WT	1.864	23.731	8.937	4.735	0.853	5.531	5.371	17.313	–	2.836	2.299	11.098	0.726	2.625	1.316	89.236
TN	0.189	2.152	0.744	0.405	0.074	0.372	0.375	0.700	2.091	–	0.752	2.207	0.209	0.468	0.225	10.963
M	0.078	0.910	0.320	0.173	0.032	0.167	0.167	0.336	1.129	0.501	–	1.123	0.070	0.202	0.094	5.301
C	2.679	29.549	10.010	5.485	1.004	4.791	4.852	8.403	22.785	6.145	4.695	–	3.749	16.938	6.419	127.502
WC	0.078	0.858	0.290	0.159	0.029	0.138	0.140	0.240	0.643	0.250	0.126	1.616	–	0.310	0.138	5.015
O	0.698	7.416	2.453	1.354	0.249	1.121	1.143	1.840	4.615	1.115	0.722	14.500	0.615	–	5.325	43.165
S	0.273	2.847	0.932	0.516	0.095	0.418	0.427	0.669	1.635	0.379	0.237	3.882	0.194	3.762	–	16.267
Total	59.501	381.728	292.026	92.967	12.932	56.207	57.901	85.829	143.393	22.738	16.320	89.805	9.284	40.140	22.039	1382.810

Note: paper products are calculated to be worth $1,090 per tonne.

Table B108 Inter-regional trade flows in petroleum (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	574.045	105.856	48.761	4.760	21.776	22.636	27.208	49.137	6.640	4.105	34.272	2.282	10.379	5.684	917.541
A	2.526	–	12.148	4.145	0.290	1.418	1.492	1.694	3.050	0.368	0.234	1.843	0.122	0.537	0.289	30.156
WK	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BP	0.415	8.017	4.214	–	0.167	0.659	0.579	0.751	1.223	0.139	0.090	0.688	0.045	0.197	0.105	17.289
G	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HB	0.068	1.011	0.431	0.243	0.061	–	0.131	0.420	0.504	0.045	0.030	0.212	0.014	0.058	0.030	3.258
T	0.298	4.470	1.937	0.896	0.085	0.0549	–	1.332	2.007	0.186	0.124	0.880	0.058	0.241	0.126	13.189
MW	0.001	0.015	0.006	0.003	0.001	0.005	0.004	–	0.020	0.001	0.001	0.005	0.000	0.001	0.001	0.064
WT	0.173	2.438	0.909	0.505	0.086	0.565	0.535	1.754	–	0.284	0.230	1.126	0.072	0.265	0.132	9.074
TN	0.061	0.772	0.2645	0.151	0.026	0.133	0.130	0.248	0.744	–	0.263	0.782	0.073	0.165	0.079	3.889
M	0.000	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–	0.000	0.000	0.000	0.000	0.000
C	0.499	6.103	2.046	1.177	0.203	0.985	0.972	1.712	4.667	1.236	0.944	–	0.752	3.439	1.292	26.027
WC	0.001	0.018	0.006	0.003	0.001	0.003	0.003	0.005	0.013	0.005	0.003	0.033	–0	0.006	0.003	0.102
O	0.091	1.070	0.350	0.203	0.035	0.161	0.160	0.262	0.660	0.157	0.101	2.066	0.086	–0	0.748	6.150
S	0.031	0.357	0.116	0.067	0.012	0.052	0.052	0.083	0.203	0.046	0.029	0.481	0.024	0.464	–	2.017
Total	4.165	598.315	128.283	56.155	5.725	26.306	26.694	35.467	62.227	9.109	6.153	42.387	3.529	15.751	8.489	1028.755

Note: petroleum is calculated to be worth $540 per tonne.

Table B109 Inter-regional trade flows in chemicals (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	6.755	1.266	0.582	0.058	0.261	0.266	0.325	0.583	0.080	0.050	0.406	0.028	0.125	0.068	10.853
A	37.329	–	166.008	56.483	4.023	19.405	20.045	23.088	41.309	5.085	3.228	24.967	1.692	7.403	3.979	414.045
WK	1.336	31.694	–	5.762	0.303	1.606	1.686	1.806	2.988	0.338	0.218	1.625	0.110	0.470	0.250	50.191
BP	1.018	17.887	9.557	–	0.386	1.496	1.290	1.698	2.750	0.320	0.205	1.546	0.105	0.451	0.241	38.948
G	0.025	0.312	0.123	0.094	–	0.094	0.031	0.073	0.116	0.014	0.009	0.066	0.004	0.019	0.010	0.990
HB	0.363	4.892	2.120	1.191	0.305	–	0.632	2.064	2.458	0.225	0.151	1.034	0.069	0.286	0.149	15.939
T	1.487	20.271	8.930	4.119	0.399	2.534	–	6.123	9.167	0.868	0.580	4.020	0.270	1.118	0.585	60.472
MW	0.830	10.685	4.377	2.482	0.436	3.789	2.802	0.000	13.948	0.766	0.553	3.286	0.219	0.850	0.433	45.455
WT	2.711	34.780	13.178	7.311	1.262	8.210	7.932	25.377	–	4.158	3.371	16.195	1.066	3.875	1.922	131.049
TN	0.114	1.303	0.454	0.259	0.045	0.228	0.220	0.424	1.266	–	0.456	1.331	0.126	0.285	0.136	6.648
M	0.058	0.678	0.240	0.136	0.024	0.126	0.120	0.251	0.841	0.374	–	0.833	0.052	0.151	0.070	3.953
C	2.317	25.750	8.776	5.036	0.883	4.228	4.099	7.323	19.838	5.356	4.092	–	3.271	14.865	5.572	111.406
WC	0.023	0.256	0.087	0.050	0.009	0.042	0.040	0.072	0.192	0.075	0.038	0.480	–	0.093	0.041	1.497
O	0.147	1.570	0.522	0.302	0.053	0.240	0.234	0.390	0.976	0.236	0.153	3.056	0.130	–	1.123	9.131
S	0.167	1.756	0.579	0.335	0.059	0.261	0.256	0.413	1.008	0.234	0.146	2.385	0.120	2.338	–	10.057
Total	47.924	158.589	216.216	84.140	8.245	42.520	39.353	69.426	97.439	18.127	13.249	61.231	7.263	32.331	14.580	910.634

Note: chemicals are calculated to be worth $1,590 per tonne.

Table B110 Inter-regional trade flows in non-metallic products (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	13.319	2.462	1.137	0.111	0.506	0.529	0.634	1.145	0.154	0.096	0.797	0.052	0.242	0.132	21.316
A	6.481	-	29.099	9.952	0.693	3.394	3.590	4.062	7.322	0.882	0.562	4.414	0.288	1.291	0.694	72.724
WK	0.409	9.937	–	1.791	0.092	0.495	0.532	0.560	0.934	0.103	0.067	0.507	0.033	0.145	0.077	15.683
BP	0.118	2.117	1.115	–	0.044	0.174	0.154	0.199	0.324	0.037	0.024	0.182	0.012	0.052	0.028	4.580
G	0.093	1.197	0.465	0.359	–	0.354	0.118	0.277	0.445	0.051	0.033	0.253	0.016	0.073	0.039	3.775
HB	0.201	2.770	1.184	0.668	0.167	–	0.360	1.157	1.388	0.124	0.084	0.582	0.038	0.159	0.083	8.963
T	0.092	1.287	0.559	0.259	0.025	0.158	–	0.385	0.580	0.054	0.036	0.254	0.016	0.070	0.036	3.811
W	0.098	1.293	0.522	0.298	0.051	0.451	0.342	–	1.683	0.090	0.065	0.396	0.025	0.101	0.051	5.468
WT	0.530	6.959	2.600	1.450	0.245	1.616	1.538	5.025	–	0.812	0.660	3.222	0.204	0.760	0.377	25.999
TN	0.106	1.246	0.427	0.245	0.042	0.215	0.212	0.401	1.206	–	0.426	1.265	0.116	0.267	0.127	6.302
M	0.018	0.218	0.076	0.043	0.007	0.040	0.039	0.080	0.270	0.117	–	0.266	0.016	0.048	0.022	12.60
C	0.478	5.436	1.827	1.054	0.181	0.878	0.872	1.530	4.176	1.103	0.846	–	0.660	3.078	1.154	23.272
WC	0.226	2.561	0.858	0.495	0.085	0.410	0.407	0.708	1.911	0.729	0.369	4.774	–	0.913	0.403	14.850
O	0.061	0.666	0.219	0.127	0.022	0.100	0.100	0.164	0.413	0.098	0.064	1.290	0.053	–	0.468	3.844
S	0.080	0.863	0.280	0.163	0.028	0.126	0.126	0.201	0.493	0.112	0.070	1.165	0.056	1.126	0.000	4.890
Total	8.991	49.869	41.693	18.042	1.793	8.920	8.920	15.382	22.291	4.467	3.402	19.366	1.585	8.324	3.693	216.737

Note: non-metallic products are calculated to be worth $1,980 per tonne.

Table B111 Inter-regional trade flows in basic and fabricated metals (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	6.647	1.235	0.576	0.056	0.257	0.261	0.320	0.578	0.078	0.049	0.402	0.027	0.122	0.064	10.673
A	16.797	–	74.196	25.638	1.795	8.759	9.024	10.431	18.799	2.276	1.448	11.326	0.762	3.315	1.700	186.267
WK	1.538	36.573	–	6.691	0.345	1.854	1.942	2.087	3.479	0.387	0.251	1.885	0.126	0.539	0.274	57.971
BP	0.257	4.532	2.399	–	0.097	0.379	0.326	0.431	0.703	0.080	0.052	0.394	0.026	0.113	0.058	9.848
G	0.047	0.598	0.234	0.182	–	0.180	0.059	0.140	0.225	0.026	0.017	0.128	0.009	0.037	0.019	1.901
HB	0.237	3.202	1.375	0.784	0.197	–	0.413	1.353	1.623	0.146	0.098	0.680	0.045	0.186	0.092	10.432
T	1.165	15.918	6.948	3.254	0.310	1.991	–	4.816	7.263	0.676	0.453	3.174	0.212	0.872	0.435	47.488
MW	0.323	4.168	1.692	0.974	0.168	1.479	1.091	–	5.490	0.296	0.214	1.289	0.085	0.329	0.160	17.760
WT	0.791	10.171	3.819	2.151	0.365	2.403	2.228	7.433	–	1.207	0.980	4.763	0.311	1.125	0.532	38.278
TN	0.130	1.495	0.516	0.299	0.051	0.262	0.252	0.487	1.465	–	0.520	1.536	0.145	0.325	0.148	7.632
M	0.027	0.318	0.112	0.064	0.011	0.059	0.056	0.118	0.398	0.174	–	0.393	0.025	0.070	0.031	1.855
C	0.758	8.445	2.852	1.662	0.287	1.388	1.342	2.406	6.565	1.743	1.335	–	1.071	4.840	1.731	36.424
WC	0.010	0.116	0.039	0.023	0.004	0.019	0.018	0.033	0.088	0.034	0.017	0.219	–	0.042	0.018	0.679
O	0.296	3.180	1.049	0.616	0.106	0.487	0.474	0.790	1.995	0.474	0.308	6.226	0.264	–	2.155	18.420
S	1.205	12.719	4.152	2.445	0.424	1.892	1.847	2.996	7.362	1.681	1.055	17.369	0.866	16.805	–	72.817
Total	23.583	108.082	100.616	45.359	4.216	21.410	19.333	33.840	56.033	9.279	6.796	49.786	3.974	28.720	7.416	518.444

Note: basic and fabricated metals are calculated to be worth $2,310 per tonne.

Table B112 Inter-regional trade flows in equipment and machinery (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	1.443	0.270	0.124	0.012	0.056	0.058	0.069	0.127	0.017	0.010	0.085	0.006	0.027	0.015	2.320
A	2.479	–	10.994	3.747	0.267	1.295	1.369	1.536	2.789	0.338	0.211	1.629	0.113	0.488	0.267	27.521
WK	0.201	4.767	–	0.865	0.046	0.243	0.261	0.272	0.457	0.051	0.032	0.240	0.017	0.070	0.038	7.559
BP	0.111	1.951	1.039	–	0.042	0.164	0.145	0.186	0.305	0.035	0.022	0.166	0.011	0.049	0.027	4.251
G	0.007	0.094	0.037	0.029	–	0.028	0.010	0.022	0.036	0.004	0.003	0.020	0.001	0.006	0.003	0.300
HB	0.051	0.682	0.295	0.166	0.043	–	0.091	0.288	0.348	0.031	0.021	0.141	0.010	0.040	0.021	2.226
T	0.061	0.826	0.363	0.168	0.016	0.104	–	0.250	0.380	0.035	0.023	0.161	0.011	0.045	0.024	2.468
MW	0.060	0.777	0.317	0.180	0.032	0.277	0.210	–	1.032	0.056	0.040	0.235	0.016	0.061	0.032	3.324
WT	0.118	1.512	0.571	0.317	0.055	0.359	0.341	1.105	–	0.181	0.144	0.691	0.046	0.167	0.084	5.692
TN	0.017	0.199	0.069	0.039	0.007	0.035	0.034	0.065	0.196	–	0.068	0.199	0.019	0.043	0.021	1.013
M	0.020	0.239	0.084	0.048	0.008	0.045	0.044	0.089	0.301	0.132	–	0.288	0.018	0.053	0.025	1.395
C	0.379	4.217	1.433	0.824	0.145	0.696	0.690	1.201	3.304	0.878	0.660	–	0.536	2.419	0.922	18.305
WC	0.009	0.096	0.033	0.019	0.003	0.016	0.016	0.027	0.073	0.028	0.014	0.177	–	0.035	0.016	0.561
O	0.059	0.632	0.210	0.121	0.021	0.097	0.097	0.157	0.399	0.095	0.061	1.208	0.053	–	0.457	3.667
S	0.019	0.199	0.066	0.038	0.007	0.030	0.030	0.047	0.116	0.027	0.016	0.266	0.014	0.264	0.000	1.138
Total	3.591	17.634	15.780	6.685	0.705	3.444	3.394	5.314	9.863	1.907	1.326	5.507	0.871	3.767	1.951	81.741

Note: equipment and machinery are calculated to be worth $21,280 per tonne.

All trade in services weighs, by definition, no tonnes, so the trade flows by weight cannot be given.

Table B113 Inter-regional trade flows from all industries (in thousands of tonnes).

Origin	Destination															
	N	**A**	**WK**	**BP**	**G**	**HB**	**T**	**MW**	**WT**	**TN**	**M**	**C**	**WC**	**O**	**S**	**Total**
N	–	1333	242	112	11	50	52	63	114	15	9	79	5	24	13	2125
A	218	–	969	329	23	112	120	136	245	29	18	147	10	43	23	2433
WK	89	2198	–	390	20	108	115	122	206	23	15	111	7	31	17	3450
BP	28	503	261	–	10	41	36	47	77	9	6	43	3	12	7	1083
G	9	136	47	37	–	36	12	29	47	5	3	26	2	8	4	392
HB	19	260	110	62	15	–	34	108	130	11	8	54	3	15	8	836
T	7	100	42	20	2	12	–	29	45	4	3	20	1	5	3	294
MW	12	168	65	38	6	57	43	–	218	12	8	51	3	13	6	701
WT	17	221	81	45	8	51	48	158	-	26	21	102	6	24	12	819
TN	9	107	36	21	3	18	18	34	104	–	35	108	10	23	11	537
M	7	87	30	17	3	15	15	31	107	45	–	105	6	19	9	497
C	23	261	87	50	8	41	41	73	201	52	39	–	31	146	55	1107
WC	29	329	108	63	11	52	52	90	244	93	47	611	–	115	51	1896
O	20	226	73	43	7	34	34	55	140	33	21	436	17	–	156	1295
S	7	81	26	15	3	12	12	19	46	10	6	109	5	104	–	454
Total	495	6000	2179	1242	131	640	633	993	1925	367	238	2003	109	581	373	17907

Table B114 Summary of all inter-regional trade flows by industry.

Industry	**Tonnes x 10^3**
Horticulture	422
Pastoral agriculture	1124
Forestry	2237
Fishing	58
Mining	7556
Meat processing	251
Dairy processing	336
Other food, beverage and tobacco	1445
Textiles	85
Wood products	253
Paper products	1383
Petroleum	1029
Chemicals	911
Non-metallic products	217
Basic and fabricated metals	518
Equipment and machinery	82
Total	17 907

Table B115 Summary of inter-regional trade flows by region for all industries.

Region	Tonnes x 10^3	
	Imports	**Exports**
Northland	495	2125
Auckland	6000	2423
Waikato	2179	3450
Bay Of Plenty	1242	1083
Gisborne	131	392
Hawkes Bay	640	836
Taranaki	633	294
Manawatu/Wanganui	993	701
Wellington	1925	819
Tasman/Nelson	367	537
Marlborough	238	497
Canterbury	2003	1107
West Coast	109	1896
Otago	581	1295
Southland	373	454
Total	17 907	17 907

B4 Tkm

This worksheet relates to Chapter A5 (in Appendix A) and converts the data on the weight of trade into tonne-kms, using information on distances between regional main towns (nodes) and assumptions about the probable route between nodes. See Tables A11 and A12 and Figure A2 for definitions of contiguous regions.

Tables B116–B130 can be seen as answers to the question 'Will goods transported from Region A to Region B use this section of the road network?' with 'Y' indicating that it will. The total tonne-kilometres (Table 131) were calculated using the data given in Table B113 and B115.

The abbreviations for the destination regions are as used for the previous spreadsheets. The following abbreviations have been used for the sections of road:

- NA: Northland–Auckland
- AK: Auckland–Waikato
- KB: Waikato–Bay of Plenty
- KH: Waikato–Hawkes Bay
- KM: Waikato–Manawatu/Wanganui
- KT: Waikato–Taranaki
- BG: Bay of Plenty–Gisborne
- BH: Bay of Plenty–Hawkes Bay
- BM: Bay of Plenty–Manawatu/Wanganui
- GH: Gisborne–Hawkes Bay
- HM: Hawkes Bay–Manawatu/Wanganui
- TM: Taranaki–Manawatu/Wanganui
- MW: Manawatu/Wanganui–Wellington
- WR: Wellington–Marlborough
- RE: Marlborough–Tasman/Nelson
- RC: Marlborough–Canterbury
- RL: Marlborough–West Coast
- EL: Tasman/Nelson–West Coast
- EC: Tasman/Nelson–Canterbury
- CL: Canterbury–West Coast
- CO: Canterbury–Otago
- OS: Otago–Southland.

The Haast Pass route, which links Otago to the West Coast, has not been considered in this study.

Table B116 Sections of the road network used by freight exporting goods from Northland.

Destination	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	(Not applicable)																					
A	Y	Y																				
WK	Y	Y																				
BP	Y	Y	Y																			
G	Y	Y	Y				Y															
HB	Y	Y		Y																		
TK	Y	Y				Y																
MW	Y	Y			Y																	
WT	Y	Y			Y								Y									
TN	Y	Y			Y								Y	Y	Y							
M	Y	Y			Y								Y	Y								
C	Y	Y			Y								Y	Y		Y						
WC	Y	Y			Y								Y	Y			Y					
O	Y	Y			Y								Y	Y		Y					Y	
S	Y	Y			Y								Y	Y		Y					Y	Y

Table B117 Sections of the road network used by freight exporting goods from Auckland.

Destination	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y																					
A	(Not applicable)																					
WK		Y																				
BP		Y	Y																			
G		Y	Y				Y															
HB		Y		Y																		
TK		Y				Y																
MW		Y			Y																	
WT		Y			Y								Y									
TN		Y			Y								Y	Y	Y							
M		Y			Y								Y	Y								
C		Y			Y								Y	Y		Y						
WC		Y			Y								Y	Y			Y					
O		Y			Y								Y	Y		Y					Y	
S		Y			Y								Y	Y		Y					Y	Y

Table B118 Sections of the road network used by freight exporting goods from Waikato.

Destination	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y																				
A		Y																				
WK	(Not applicable)																					
BP			Y																			
G			Y				Y															
HB				Y																		
TK						Y																
MW						Y																
WT						Y							Y									
TN						Y							Y	Y	Y							
M					Y								Y	Y								
C					Y								Y	Y		Y						
WC					Y								Y	Y			Y					
O					Y								Y	Y		Y					Y	
S					Y								Y	Y		Y					Y	Y

Table B119 Sections of the road network used by freight exporting goods from Bay of Plenty.

Destinatio	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y	Y																			
A		Y	Y																			
WK			Y																			
BP	(Not applicable)																					
G							Y															
HB								Y														
TK			Y			Y																
MW									Y													
WT									Y				Y									
TN									Y				Y	Y	Y							
M									Y				Y	Y								
C									Y				Y	Y		Y						
WC									Y				Y	Y			Y					
O									Y				Y	Y		Y					Y	
S									Y				Y	Y		Y					Y	Y

Table B120 Sections of the road network used by freight exporting goods from Gisborne.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y	Y				Y															
A		Y	Y				Y															
WK			Y				Y															
BP							Y															
G	(Not applicable)																					
HB										Y												
TK										Y	Y	Y										
MW										Y	Y	Y										
WT										Y	Y		Y									
TN										Y	Y		Y	Y	Y							
M										Y	Y		Y	Y								
C										Y	Y		Y	Y		Y						
WC										Y	Y		Y	Y			Y					
O										Y	Y		Y	Y		Y					Y	
S										Y	Y		Y	Y		Y					Y	Y

Table B121 Sections of the road network used by freight exporting goods from Hawkes Bay.

Destinatio	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y		Y																		
A		Y		Y																		
WK				Y																		
BP								Y														
G										Y												
HB	(Not applicable)																					
TK											Y	Y										
MW											Y		Y									
WT											Y		Y									
TN											Y		Y	Y	Y							
M											Y		Y	Y								
C											Y		Y	Y		Y						
WC											Y		Y	Y			Y					
O											Y		Y	Y		Y					Y	
S											Y		Y	Y		Y					Y	Y

Table B122 Sections of the road network used by freight exporting goods from Taranaki.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y				Y																
A		Y				Y																
WK						Y																
BP			Y			Y																
G										Y	Y	Y										
HB											Y	Y										
TK	(Not applicable)																					
MW												Y										
WT												Y	Y									
TN												Y	Y	Y	Y							
M												Y	Y	Y								
C												Y	Y	Y			Y					
WC												Y	Y	Y			Y					
O												Y	Y	Y		Y					Y	
S												Y	Y	Y		Y					Y	Y

Table B123 Sections of the road network used by freight exporting goods from Manawatu/Wanganui.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y																	
A		Y			Y																	
WK					Y																	
BP									Y													
G										Y	Y											
HB											Y											
TK												Y										
MW	(Not applicable)																					
WT													Y									
TN													Y	Y	Y							
M													Y	Y								
C													Y	Y		Y						
WC													Y	Y			Y					
O													Y	Y		Y					Y	
S													Y	Y		Y					Y	Y

Table B124 Sections of the road network used by freight exporting goods from Wellington.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y									
A		Y			Y								Y									
WK					Y								Y									
BP									Y				Y									
G										Y	Y		Y									
HB											Y		Y									
TK												Y	Y									
MW													Y									
WT	(Not applicable)																					
TN														Y	Y							
M														Y								
C														Y		Y						
WC														Y			Y					
O														Y		Y					Y	
S														Y		Y					Y	Y

Table B125 Sections of the road network used by freight exporting goods from Tasman/Nelson.

Destination	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y	Y							
A		Y			Y								Y	Y	Y							
WK					Y								Y	Y	Y							
BP									Y				Y	Y	Y							
G										Y	Y		Y	Y	Y							
HB											Y		Y	Y	Y							
TK												Y	Y	Y	Y							
MW													Y	Y	Y							
WT														Y	Y							
TN	(Not applicable)																					
M															Y							
C																			Y			
WC																		Y				
O																			Y		Y	
S																			Y		Y	Y

Table B126 Sections of the road network used by freight exporting goods from Marlborough.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y								
A		Y			Y								Y	Y								
WK					Y								Y	Y								
BP									Y				Y	Y								
G										Y	Y		Y	Y								
HB											Y		Y	Y								
TK												Y	Y	Y								
MW													Y	Y								
WT														Y								
TN															Y							
M	(Not applicable)																					
C																Y						
WC																	Y					
O																Y					Y	
S																Y					Y	Y

Table B127 Sections of the road network used by freight exporting goods from Canterbury.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y		Y						
A		Y			Y								Y	Y		Y						
WK					Y								Y	Y		Y						
BP									Y				Y	Y		Y						
G										Y	Y		Y	Y		Y						
HB											Y		Y	Y		Y						
TK												Y	Y	Y		Y						
MW													Y	Y		Y						
WT														Y		Y						
TN																			Y			
M																Y						
C	(Not applicable)																					
WC																				Y		
O																					Y	
S																					Y	Y

Table B128 Sections of the road network used by freight exporting goods from the West Coast.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y			Y					
A		Y			Y								Y	Y			Y					
WK					Y								Y	Y			Y					
BP									Y				Y	Y			Y					
G										Y	Y		Y	Y			Y					
HB											Y		Y	Y			Y					
TK												Y	Y	Y			Y					
MW													Y	Y			Y					
WT														Y			Y					
TN																		Y				
M																	Y					
C																				Y		
WC	(Not applicable)																					
O																				Y	Y	
S																				Y	Y	Y

Table B129 Sections of the road network used by freight exporting goods from Otago.

Destination	Section of the road network																					
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y		Y					Y	
A		Y			Y								Y	Y		Y					Y	
WK					Y								Y	Y		Y					Y	
BP									Y				Y	Y		Y					Y	
G										Y	Y		Y	Y		Y					Y	
HB											Y		Y	Y		Y					Y	
TK												Y	Y	Y		Y					Y	
MW													Y	Y		Y					Y	
WT														Y		Y					Y	
TN																			Y		Y	
M																Y					Y	
C																					Y	
WC																				Y	Y	
O	(Not applicable)																					
S																						Y

Table B130 Sections of the road network used by freight exporting goods from Southland.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	Y	Y			Y								Y	Y		Y					Y	Y
A		Y			Y								Y	Y		Y					Y	Y
WK					Y								Y	Y		Y					Y	Y
BP									Y				Y	Y		Y					Y	Y
G										Y	Y		Y	Y		Y					Y	Y
HB											Y		Y	Y		Y					Y	Y
TK												Y	Y	Y		Y					Y	Y
MW													Y	Y		Y					Y	Y
WT														Y		Y					Y	Y
TN																			Y		Y	Y
M																Y					Y	Y
C																					Y	Y
WC																				Y	Y	Y
O																						Y
S	(Not applicable)																					

Table B131 Total million tonne-kilometres for goods transported on each trip segment.

Destination	Section of the road network																				
	NA	AK	KB	KH	KM	KT	BG	BH	BM	GH	HM	TM	MW	WR	RE	RC	RL	EL	EC	CL	CO	OS
N	359.0	99.7	13.1	14.8	132.8	12.1	3.2	0.0	0.0	0.0	0.0	0.0	37.7	18.7	1.8	35.9	1.6	0.0	0.0	0.0	13.4	2.8
A	36.8	277.8	37.4	33.1	267.8	27.6	6.9	0.0	0.0	0.0	0.0	0.0	74.8	34.6	3.4	65.7	3.1	0.0	0.0	0.0	23.9	5.0
WK	15.0	288.1	43.4	31.9	218.1	26.7	5.9	0.0	0.0	0.0	0.0	0.0	59.3	26.0	2.6	49.0	2.2	0.0	0.0	0.0	17.4	3.6
BP	4.7	66.9	87.8	0.0	0.0	8.4	3.1	12.2	84.3	0.0	0.0	0.0	22.6	10.1	1.0	19.1	0.9	0.0	0.0	0.0	6.9	1.4
G	1.6	17.1	19.4	0.0	0.0	0.0	65.6	0.0	0.0	37.0	24.2	2.9	13.8	6.2	0.6	11.7	0.6	0.0	0.0	0.0	4.2	0.9
HB	3.2	35.1	0.0	114.7	0.0	0.0	0.0	18.5	0.0	3.3	66.0	7.9	33.3	12.7	1.3	23.6	1.1	0.0	0.0	0.0	8.1	1.7
TK	1.2	13.5	2.1	0.0	0.0	39.1	0.0	0.0	0.0	0.4	2.5	29.1	11.7	4.6	0.5	8.5	0.4	0.0	0.0	0.0	2.9	0.6
MW	2.1	22.8	0.0	0.0	101.1	0.0	0.0	0.0	15.7	1.4	11.3	10.0	45.1	11.9	1.3	21.6	1.0	0.0	0.0	0.0	7.0	1.4
WT	2.8	30.0	0.0	0.0	131.1	0.0	0.0	0.0	18.9	1.6	10.4	11.3	91.1	24.3	3.0	42.4	2.1	0.0	0.0	0.0	12.9	2.6
TN	1.5	14.6	0.0	0.0	62.7	0.0	0.0	0.0	8.6	0.7	3.8	4.2	35.8	44.9	44.7	0.0	0.0	2.8	60.0	0.0	12.1	2.4
M	1.2	11.8	0.0	0.0	50.8	0.0	0.0	0.0	7.1	0.6	3.3	3.6	29.9	40.1	5.2	40.8	2.0	0.0	0.0	0.0	9.9	1.9
C	3.9	35.7	0.0	0.0	152.2	0.0	0.0	0.0	20.7	1.8	8.8	9.7	84.7	100.4	0.0	253.7	0.0	0.0	21.9	8.1	72.6	11.9
WC	4.9	45.0	0.0	0.0	191.4	0.0	0.0	0.0	26.2	2.3	11.2	12.1	106.5	125.2	0.0	0.0	332.1	27.0	0.0	200.6	60.2	11.1
O	3.5	31.1	0.0	0.0	131.4	0.0	0.0	0.0	17.7	1.6	7.3	7.9	71.4	80.9	0.0	201.2	0.0	0.0	13.9	4.3	412.2	33.9
S	1.3	11.1	0.0	0.0	46.9	0.0	0.0	0.0	6.3	0.6	2.5	2.7	25.2	28.2	0.0	69.8	0.0	0.0	4.4	1.3	126.9	98.6
Total	442.7	1000.3	203.2	194.5	1486.2	113.8	84.7	30.7	205.5	51.3	151.4	101.5	742.9	568.8	65.4	843.0	347.1	29.8	100.2	214.3	790.6	179.6
Share	0.056	0.126	0.026	0.024	0.187	0.014	0.011	0.004	0.026	0.006	0.019	0.013	0.093	0.072	0.008	0.106	0.044	0.004	0.013	0.027	0.099	0.023

Appendix C TNZ traffic counts

C1 Annual average daily totals (AADT)

In the tables presented in this appendix, the shaded cells indicate values that were missing in the original data. The values in these shaded cells have been interpolated, using the traffic counts in adjacent years.

Table C1 TNZ AADTs of traffic counts in Northland.

Year	State Highway	Locality (telemetry sites)	
		Kawakawa	Wellsford
1997	1N	4955	6765
1998		5100	7075
1999		5180	7270
2000		5260	7140
2001		5350	7700
2002		5660	8120
2003		5640	8650
2004		6010	9030

Table C2 TNZ AADTs of traffic counts in the Auckland region.

Year	State Highway	Locality (telemetry sites)				
		Hadfields Beach	Auckland Harbour Bridge	Panama Road	Drury	Bombay
1997	1N	13 285	144 400	100 740	43 860	26 550
1998		12 600	149 300	102 680	44 430	27 305
1999		14 210	151 050	104 200	45 600	29 150
2000		14 970	155 160	104 620	49 190	29 140
2001		15 450	150 610	105 720	47 070	31 720
2002		16 130	155 260	108 940	48 700	31 700
2003		16 800	162 960	111 090	53 290	32 520
2004		17 330	161 990	111 800	55 900	34 220

Table C3 TNZ AADTs of traffic counts in Waikato.

Year	State Highway and telemetry site									
	1N				2		3	25A	27	32
	Taupiri	Karapiro	Lichfield	Hallets Bay	Mangatawhiri	Waihi	Te Kuiti	Hikuae	Kaihere	West Lake Taupo
1997	15500	11495	8330	5050	11 035	6300	3505	2435	4095	540
1998	15990	12125	7890	5390	11 575	6420	3430	2770	4260	655
1999	16370	12400	7800	5250	11 940	6695	3645	3150	4420	675
2000	16440	12330	8010	5400	13 110	6970	3670	3000	4500	670
2001	16760	12900	8990	5170	12 210	6520	3730	3060	4610	670
2002	17030	13340	9160	5500	12 790	6830	3850	3010	4700	750
2003	17900	13820	9110	5550	13 500	7180	4030	3930	4800	690
2004	18970	14240	9170	5780	13 640	7430	4180	3380	4820	700

Table C4 TNZ AADTs of traffic counts in Bay of Plenty.

Year	State Highway and telemetry site							
	2	5			29	30	33	
	Te Puna	Omanapanea	Tarukenga	Waipa	Kaimai	Te Ngae (Rotorua)	Lake Rotoma	Paengaroa
1997	11 470	3920	4380	6050	5855	32 105	2855	4305
1998	11 980	3845	4465	5870	6225	32 680	2885	4160
1999	12 630	3990	4620	6010	6520	32 740	2793	4270
2000	12 610	4490	4650	6370	6710	32 210	2700	4210
2001	13 160	4170	4820	6660	7300	33 620	2790	4300
2002	13 910	4400	5060	7030	7800	34 210	2880	4350
2003	14 570	4560	5170	7260	8660	35 190	2950	4360
2004	15 310	4710	5300	7460	8930	35 430	3000	4650

Table C5 TNZ AADTs of traffic counts in the Gisborne region.

Year	State Highway	Locality (telemetry site)
		Ormond
1997	2	2195
1998		2250
1999		2340
2000		2420
2001		2320
2002		2420
2003		2500
2004		2490

Table C6 TNZ AADTs of traffic counts in Hawkes Bay.

Year	State Highway and telemetry site		
	2	5	50
	Tangoio	Te Pohue	Napier South*
1997	1570	2210	11 625
1998	1640	2300	12 535
1999	1735	2455	14 520
2000	1780	2500	15 880
2001	1750	2630	16 210
2002	1800	2830	17 200
2003	1940	2870	18 610
2004	2000	2940	19 830

* The figures for 1997 are actually 1996 data.

Table C7 TNZ AADTs of traffic counts in Taranaki.

Year	State Highway and telemetry site			
	3			45
	Tongaporutu	Tariki	Waitotara	Hawera
1997	2070	6940	3130	3700
1998	1620	6840	3170	3790
1999	1750	6825	3170	3700
2000	1870	6810	3230	3610
2001	1880	7120	3280	3710
2002	1950	7440	3350	3760
2003	2020	7700	3440	3810
2004	2070	8090	3440	3830

Table C8 TNZ AADTs of traffic counts in the Manawatu/Wanganui region.

Year	State highway and telemetry site						
	1N			2	3	4	
	Hihitahi	Sanson	Ohau	Norsewood	Manawatu Gorge	Horopito	Upokongaro
1997	4030	11 030	13 020	3620	5880	1620	1860
1998	4240	11 140	13 490	3365	5850	1460	1925
1999	4470	11 510	13 965	3545	6150	1570	1975
2000	4260	11 400	13 140	3570	6150	1640	1920
2001	4310	11 550	14 100	33590	6430	1760	1860
2002	4420	11 830	14 400	3900	6730	1720	1840
2003	4730	11 840	14 830	3960	6840	1870	1940
2004	4830	12 000	14 980	3980	6360	2010	1960

Table C9 TNZ AADTs of traffic counts in the Wellington region.

Year	State Highway and telemetry site					
	1N		2			58
	Pukerua Bay	Ngauranga Gorge	Clareville	Rimutaka	Ngauranga Gorge	Pauatahunui
1997	20 610	38 490	8047	4200	41 560	11 100
1998	19 940	39 570	8130	4480	41 835	11 490
1999	21 550	40 680	8090	4700	42 240	11 750
2000	21 390	41 350	7920	4970	43 200	11 730
2001	21 170	42 620	8380	4850	42 610	12 000
2002	21 590	43 460	8700	4980	43 140	12 400
2003	22 200	44 130	8930	5050	44 100	12 830
2004	21 960	43 920	9820	5240	43 980	13 160

Table C10 TNZ AADTs of traffic counts for the Tasman/Nelson and Marlborough regions.

Year	State Highway and telemetry site		
	6		
	Hira	Stoke	Murchison
1997	2400	14 570	1340
1998	2510	16 010	1370
1999	2650	17 450	1465
2000	2760	17 450	1500
2001	2710	18 250	1530
2002	3020	19 580	1650
2003	3170	20 050	1720
2004	3240	20 230	1760

Table C11 TNZ AADTs of traffic counts for Canterbury.

Year	State Highway and telemetry site					
	1S				7	73
	Kaikoura	Dunsandel*	Timaru	St Andrews	Lewis Pass	Springfield
1997	1800	6355	18 600	4560	965	1300
1998	1890	6900	19 000	4640	1010	1180
1999	2145	7280	18 600	4770	1020	1320
2000	2240	7710	19 390	4740	1050	1270
2001	2170	7460	18 920	4940	960	1380
2002	2260	7820	19 410	5140	1530	1470
2003	2320	8320	20 010	5300	1030	1550
2004	2510	9200	20 690	5440	1170	1650

* The 1997 data values are actually 1996 data.

Table C12 TNZ AADTs of traffic counts on the West Coast.

Year	State Highway and telemetry site		
	6		7
	Punakaiki	Chesterfield	Ahaura
1997	735	1990	900
1998	745	2010	925
1999	750	2050	970
2000	800	2110	990
2001	890	2130	970
2002	840	2360	980
2003	870	2470	1080
2004	970	2610	1120

Table C13 TNZ AADTs of traffic counts in Otago.

Year	State Highway and telemetry site		
	1S		8
	Burnside	Milton*	Alexandra*
1997	20 130	4680	1610
1998	20 110	5030	1650
1999	20 250	4925	1720
2000	20 030	4820	1767
2001	20 050	5390	1830
2002	22 420	5780	1930
2003	24 450	5920	2040
2004	25 190	5990	2080

- The 1997 data values are actually 1996 data.

Table C14 TNZ AADTs of traffic counts in Southland.

Year	State Highway and telemetry site		
	1S		6
	Gore*	Invercargill*	Winton*
1997	3470	10 455	3455
1998	3565	10 440	3595
1999	3680	10 365	3725
2000	3731	10 222	3756
2001	3830	11 020	4020
2002	3940	11 580	4230
2003	3880	11 650	4250
2004	3980	11 680	4370

- The 1997 data values are actually 1996 data.

C2 Percentage of heavy motor vehicle (HMV) movements

Table C15 TNZ percentage of HMV movements in Northland.

Year	State Highway and telemetry site	
	1N	
	Kawakawa	Wellsford
1997	8%	7%
1998	8%	7%
1999	9%	7%
2000	9%	7%
2001	9%	8%
2002	10%	8%
2003	10%	10%
2004	9%	10%

Table C16 TNZ percentage of HMV movements in the Auckland region.

Year	State Highway and telemetry site				
	1N				
	Hadfields Beach	Auckland Harbour Bridge	Panama Road	Drury	Bombay
1997	6%	5%	5%	7%	10%
1998	6%	5%	5%	8%	10%
1999	6%	5%	5%	8%	10%
2000	7%	5%	5%	8%	10%
2001	7%	5%	5%	8%	9%
2002	7%	5%	5%	8%	10%
2003	7%	5%	5%	8%	10%
2004	6%	5%	5%	9%	11%

Table C17 TNZ percentage of HMV movements in Waikato.

Year	State Highway and telemetry site									
	1N				2		3	25A	27	32
	Taupiri	Karapiro	Lichfield	Hallets Bay	Mangatawhiri	Waihi	Te Kuiti	Hikuae	Kaihere	West Lake Taupo
1997	11%	9%	12%	12%	10%	8%	12%	11%	15%	7%
1998	11%	9%	14%	11%	10%	8%	12%	8%	14%	10%
1999	10%	9%	15%	11%	10%	8%	12%	8%	15%	12%
2000	11%	10%	16%	13%	10%	10%	13%	9%	15%	13%
2001	10%	10%	15%	14%	11%	10%	13%	9%	16%	10%
2002	10%	10%	15%	14%	11%	11%	14%	9%	16%	14%
2003	13%	12%	18%	15%	15%	10%	16%	8%	19%	7%
2004	11%	10%	16%	13%	12%	11%	15%	7%	18%	10%

Table C18 TNZ percentage of HMV movements in Bay of Plenty.

Year	State Highway and telemetry site							
	2		5		29	30		33
	Te Puna	Onhinepanea	Tarukenga	Waipa	Kaimai	Te Ngae (Rotorua)	Lake Rotoma	Paengaroa
1997	6%	16%	9%	10%	12%	4%	9%	13%
1998	6%	14%	9%	9%	11%	4%	9%	12%
1999	5%	14%	9%	9%	11%	4%	9%	12%
2000	23%	24%	9%	10%	12%	4%	10%	13%
2001	7%	14%	10%	10%	10%	4%	10%	14%
2002	10%	15%	10%	10%	6%	4%	10%	14%
2003	8%	15%	14%	14%	12%	6%	11%	17%
2004	7%	14%	11%	9%	12%	5%	10%	13%

Table C19 TNZ percentage of HMV movements in the Gisborne region.

Year	State Highway and telemetry site
	2
	Ormond
1997	10%
1998	10%
1999	10%
2000	10%
2001	10%
2002	10%
2003	12%
2004	11%

Table C20 TNZ percentage of HMV movements in Hawkes Bay.

Year	State Highway and telemetry site		
	2	5	50
	Tangoio	Te Pohue	Napier South*
1997	13%	14%	6%
1998	14%	13%	5%
1999	15%	14%	5%
2000	17%	15%	5%
2001	18%	17%	5%
2002	18%	18%	5%
2003	17%	22%	6%
2004	15%	16%	6%

* The 1997 data values are actually 1996 data.

Table C21 TNZ percentage of HMV movements in Taranaki.

Year	State Highway and telemetry site			
	3			45
	Tongaporutu	Tariki	Waitotara	Hawera
1997	12%	8%	11%	10%
1998	16%	8%	10%	9%
1999	16%	8%	8%	7%
2000	17%	9%	11%	9%
2001	17%	10%	13%	9%
2002	18%	10%	13%	9%
2003	18%	9%	14%	9%
2004	17%	10%	16%	10%

Table C22 TNZ percentage of HMV movements in the Manawatu/Wanganui region.

Year	State Highway and telemetry site						
	1N			2	3	4	
	Hihitahi	Sanson	Ohau	Norsewood	Manawatu Gorge	Horopito	Upokongaro
1997	14%	10%	7%	13%	10%	11%	7%
1998	14%	9%	7%	13%	9%	12%	7%
1999	14%	9%	7%	13%	9%	11%	8%
2000	12%	10%	8%	14%	10%	12%	9%
2001	10%	10%	9%	15%	11%	11%	8%
2002	11%	10%	9%	14%	11%	13%	9%
2003	15%	11%	9%	15%	11%	13%	7%
2004	16%	11%	9%	15%	12%	15%	9%

Table C23 TNZ percentage of HMV movements in the Wellington region.

Year	State Highway and telemetry site					
	1N		2			58
	Pukerua Bay	Ngauranga Gorge	Clareville	Rimutaka	Ngauranga Gorge	Pauatahunui
1997	5%	2%	6%	5%	2%	3%
1998	8%	2%	6%	4%	2%	3%
1999	5%	2%	5%	4%	2%	2%
2000	4%	3%	6%	4%	3%	3%
2001	4%	2%	6%	5%	3%	3%
2002	4%	3%	6%	5%	3%	3%
2003	12%	4%	12%	11%	2%	6%
2004	6%	2%	7%	5%	3%	3%

Table C24 TNZ percentage of HMV movements in the Tasman/Nelson and Marlborough regions.

Year	State Highway and telemetry site		
	6		
	Hira	Stoke	Murchison
1997	11%	6%	12%
1998	11%	6%	12%
1999	11%	6%	12%
2000	11%	7%	13%
2001	14%	7%	13%
2002	14%	5%	13%
2003	16%	8%	16%
2004	12%	7%	11%

Table C25 TNZ percentage of HMV movements in Canterbury.

Year	State Highway and telemetry site					
	1S				7	73
	Kaikoura	Dunsandel*	Timaru	St Andrews	Lewis Pass	Springfield
1997	12%	12%	5%	12%	15%	7%
1998	12%	12%	5%	13%	15%	8%
1999	11%	13%	5%	16%	15%	7%
2000	13%	13%	6%	16%	15%	8%
2001	16%	13%	6%	18%	21%	9%
2002	16%	14%	6%	19%	25%	10%
2003	12%	12%	7%	12%	9%	9%
2004	14%	13%	7%	15%	14%	11%

* The 1997 data values are actually 1996 data.

Table C26 TNZ percentage of HMV movements on the West Coast.

Year	State Highway and telemetry site		
	6		7
	Punakaiki	Chesterfield	Ahaura
1997	8%	9%	13%
1998	9%	9%	13%
1999	8%	9%	11%
2000	13%	10%	12%
2001	8%	9%	18%
2002	8%	10%	14%
2003	12%	13%	17%
2004	8%	10%	14%

Table C27 TNZ percentage of HMV movements in Otago.

Year	State Highway and telemetry site		
	1S		8
	Burnside	Milton*	Alexandra*
1997	5%	10%	8%
1998	5%	10%	8%
1999	5%	11%	8%
2000	5%	11%	9%
2001	5%	12%	9%
2002	5%	12%	9%
2003	5%	12%	8%
2004	6%	14%	9%

* The 1997 data values are actually 1996 data.

Table C28 TNZ percentage of HMV movements in Southland.

Year	State Highway and telemetry site		
	1S		6
	Gore*	Invercargill*	Winton*
1997	9%	3%	8%
1998	9%	3%	8%
1999	10%	3%	8%
2000	11%	3%	8%
2001	12%	3%	9%
2002	12%	3%	8%
2003	11%	3%	8%
2004	11%	3%	9%

* The 1997 data values are actually 1996 data.

C3 Derived HMV movements

Table C29 Derived HMV movements based on AADTS and the percentage of HMV movements in Northland.

Year	State Highway and telemetry site	
	1N	
	Kawakawa	Wellsford
1997	396	474
1998	408	495
1999	440	509
2000	473	500
2001	482	616
2002	538	650
2003	564	865
2004	541	903

Table C30 Derived HMV movements based on AADTS and the percentage of HMV movements in the Auckland region.

Year	State Highway and telemetry site				
	1N				
	Hadfields Beach	Auckland Harbour Bridge	Panama Road	Drury	Bombay
1997	797	7220	5037	3070	2655
1998	756	7465	5134	3554	2731
1999	853	7553	5210	3648	2915
2000	1048	7758	5231	3935	2914
2001	1082	7531	5286	3766	2855
2002	1129	7763	5447	3896	3170
2003	1176	8148	5555	4263	3252
2004	1040	8100	5590	5031	3764

Table C31 Derived HMV movements based on AADTS and the percentage of HMV movements in Waikato.

Year	State Highway and telemetry site									
	1N				2		3	25A	27	32
	Taupiri	Karapiro	Lichfield	Hallets Bay	Mangatawhiri	Waihi	Te Kuiti	Hikuae	Kaihere	West Lake Taupo
1997	1705	1035	1000	606	1104	504	421	268	614	38
1998	1759	1091	1105	593	1158	514	412	222	596	66
1999	1637	1116	1170	578	1194	536	437	252	663	81
2000	1808	1233	1282	675	1311	697	477	270	675	87
2001	1676	1290	1349	724	1343	652	485	275	738	67
2002	1703	1334	1374	770	1407	751	539	271	752	105
2003	2327	1658	1640	833	2025	718	645	271	912	48
2004	2087	1424	1467	751	1637	817	627	237	868	70

Table C32 Derived HMV movements based on AADTS and the percentage of HMV movements in Bay of Plenty.

Year	State Highway and telemetry site							
	2		5		29	30		33
	Te Puna	Onhinepanea	Tarukenga	Waipa	Kaimai	Te Ngae (Rotorua)	Lake Rotoma	Paengaroa
1997	688	627	394	605	703	1284	257	560
1998	719	538	402	528	685	1307	260	499
1999	632	559	416	541	717	1310	251	512
2000	2900	1078	419	637	805	1288	270	547
2001	921	584	482	666	730	1345	279	602
2002	1391	660	506	703	468	1368	288	609
2003	1166	684	724	1016	1039	2111	325	741
2004	1072	659	583	671	1072	1772	300	605

Table C33 Derived HMV movements based on AADTS and the percentage of HMV movements in the Gisborne region.

Year	State Highway and telemetry site
	2
	Ormond
1997	220
1998	225
1999	234
2000	242
2001	232
2002	242
2003	300
2004	274

Table C34 Derived HMV movements based on AADTS and the percentage of HMV movements in Hawkes Bay.

Year	State Highway and telemetry site		
	2	5	50
	Tangoio	Te Pohue	Napier South*
1997	204	309	698
1998	230	299	627
1999	260	344	726
2000	303	375	794
2001	315	447	811
2002	324	509	860
2003	330	631	1117
2004	300	470	1190

* The 1997 data values are derived from 1996 data.

Table C35 Derived HMV movements based on AADTS and the percentage of HMV movements in Taranaki.

Year	State Highway and telemetry site			
	3			45
	Tongaporutu	Tariki	Waitotara	Hawera
1997	248	555	344	370
1998	259	547	317	341
1999	280	546	254	259
2000	318	613	355	325
2001	320	712	426	334
2002	351	744	436	338
2003	364	693	482	343
2004	352	809	550	383

Table C36 Derived HMV movements based on AADTS and the percentage of HMV movements in the Manawatu/Wanganui region.

Year	State Highway and telemetry site						
	1N			2	3	4	
	Hihitahi	Sanson	Ohau	Norsewood	Manawatu Gorge	Horopito	Upokongaro
1997	564	1103	911	471	588	178	130
1998	594	1003	944	437	527	175	135
1999	626	1036	978	461	554	173	158
2000	511	1140	1051	500	615	197	173
2001	431	1155	1269	539	707	194	149
2002	486	1183	1296	546	740	224	166
2003	710	1302	1335	594	752	243	136
2004	773	1320	1348	597	763	302	176

Table C37 Derived HMV movements based on AADTS and the percentage of HMV movements in the Wellington region.

Year	State Highway and telemetry site					
	1N		2			58
	Pukerua Bay	Ngauranga Gorge	Clareville	Rimutaka	Ngauranga Gorge	Pauatahunui
1997	1031	770	447	210	831	333
1998	1595	791	461	179	837	345
1999	1078	814	405	188	845	235
2000	856	1241	475	199	1080	352
2001	847	852	503	243	1278	360
2002	864	1304	522	249	1294	372
2003	2664	1765	1072	556	882	770
2004	1318	878	687	262	1319	395

Table C38 Derived HMV movements based on AADTS and the percentage of HMV movements in the Tasman/Nelson and Marlborough regions.

Year	State Highway and telemetry site		
	6		
	Hira	Stoke	Murchison
1997	264	926	161
1998	276	1030	164
1999	292	1060	176
2000	304	1144	195
2001	379	1217	199
2002	423	979	215
2003	507	1604	275
2004	389	1416	194

Table C39 Derived HMV movements based on AADTS and the percentage of HMV movements in Canterbury.

Year	State Highway and telemetry site					
	1S				7	73
	Kaikoura	Dunsandel*	Timaru	St Andrews	Lewis Pass	Springfield
1997	216	763	930	547	145	91
1998	227	828	950	603	152	94
1999	236	946	930	763	153	92
2000	291	1002	1066	758	158	102
2001	347	970	1135	889	202	124
2002	362	1095	1165	977	383	147
2003	278	998	1401	636	93	140
2004	351	1196	1448	816	164	182

* The 1997 data values are derived from 1996 data.

Table C40 Derived HMV movements based on AADTS and the percentage of HMV movements on the West Coast.

Year	State Highway and telemetry site		
	6		7
	Punakaiki	Chesterfield	Ahaura
1997	59	179	117
1998	67	181	120
1999	60	185	107
2000	104	211	119
2001	71	192	175
2002	67	236	137
2003	104	321	184
2004	78	261	157

Table C41 Derived HMV movements based on AADTS and the percentage of HMV movements in Otago.

Year	State Highway and telemetry site		
	1S		8
	Burnside	Milton*	Alexandra*
1997	1007	468	129
1998	1006	503	132
1999	1013	517	138
2000	1002	530	159
2001	1003	647	165
2002	1121	694	174
2003	1223	710	163
2004	1511	839	187

* The 1997 data values are derived from 1996 data.

Table C42 Derived HMV movements based on AADTS and the percentage of HMV movements in Southland.

Year	Locality		
	1S		6
	Gore*	Invercargill*	Winton*
1997	312	314	276
1998	321	313	288
1999	368	311	298
2000	410	307	300
2001	460	331	362
2002	473	347	338
2003	427	350	340
2004	438	350	393

* The 1997 data values are actually 1996 data.

C4 Derived annual HMV movements

Table C43 Derived annual HMV movements in Northland.

Year	State Highway and telemetry site	
	1N	
	Kawakawa	Wellsford
1997	118 920	142 065
1998	122 400	148 575
1999	132 090	152 670
2000	142 020	149 940
2001	144 450	184 800
2002	161 310	194 880
2003	169 200	259 500
2004	162 270	270 900

Table C44 Derived annual HMV movements in the Auckland region.

Year	State Highway and telemetry site				
	1N				
	Hadfields Beach	Auckland Harbour Bridge	Panama Road	Drury	Bombay
1997	239 130	2 166 000	1 511 100	921 0600	796 500
1998	226 800	2 239 500	1 540 200	1 066 320	819 150
1999	255 780	2 265 750	1 563 000	1 094 400	874 500
2000	314 670	2 327 400	1 569 300	1 180 560	874 200
2001	324 450	2 259 150	1 585 800	1 129 680	856 440
2002	338 730	2 328 900	1 634 100	1 168 800	951 000
2003	352 800	2 444 400	1 666 350	1 278 960	975 600
2004	311 940	2 429 850	1 677 000	1 509 300	1 129 260

Table C45 Derived annual HMV movements in Waikato.

Year	State Highway and telemetry site									
	1N				2		3	25A	27	32
	Taupiri	Karapiro	Lichfield	Hallets Bay	Mangatawhiri	Waihi	Te Kuiti	Hikuae	Kaihere	West Lake Taupo
1997	511 500	310 365	299 880	181 800	331 050	151 200	126 180	80 355	184 275	11 340
1998	527 670	327 375	331 380	177 870	347 250	154 080	123 480	66 480	178 920	19 650
1999	491 100	334 800	351 000	173 250	358 200	160 680	131 220	75 600	198 900	24 300
2000	542 520	369 900	384 480	202 500	393 300	209 100	143 130	81 000	202 500	26 130
2001	502 800	387 000	404 550	202 140	402 930	195 600	145 470	82 620	221 280	20 100
2002	510 900	400 200	412 200	231 000	422 070	225 390	161 700	81 270	225 600	31 500
2003	698 100	497 520	491 940	249 750	607 500	215 400	193 440	81 360	273 600	14 490
2004	626 010	427 200	440 160	225 420	491 040	245 190	188 100	70 980	260 280	21 000

Table C46 Derived annual HMV movements in Bay of Plenty.

Year	State Highway and telemetry site							
	2		5		29	30		33
	Te Puna	Onhinepanea	Tarukenga	Waipa	Kaimai	Te Ngae (Rotorua)	Lake Rotoma	Paengaroa
1997	206 460	188 160	118 260	181 500	210 780	385 260	77 085	167 895
1998	215 640	161 490	120 555	158 490	205 425	392 160	77 895	149 760
1999	189 450	167 580	124 740	162 270	215 160	392 880	75 398	153 720
2000	870 090	323 280	125 550	191 100	241 560	386 520	81 000	164 190
2001	276 360	175 140	144 600	199 800	219 000	403 440	83 700	180 600
2002	417 300	198 000	151 800	210 600	140 400	410 520	86 400	182 700
2003	349 680	205 200	217 140	304 920	311 760	633 420	97 350	222 360
2004	321 510	197 820	174 900	201 420	321 480	531 450	90 000	181 350

Table C47 Derived annual HMV movements in the Gisborne region.

Year	State Highway and telemetry site
	6
	Ormond
1997	65 850
1998	67 500
1999	70 200
2000	72 600
2001	69 600
2002	72 600
2003	90 000
2004	82 170

Table C48 Derived annual HMV movements in Hawkes Bay.

Year	State Highway and telemetry site		
	2	5	50
	Tangoio	Te Pohue	Napier South
1997	61 230	92 820	209 250
1998	668 880	89 700	188 025
1999	78 075	103 110	217 800
2000	90 780	112 500	238 200
2001	94 500	134 103	243 150
2002	97 200	152 820	258 000
2003	97 940	189 420	334 980
2004	90 000	141 120	356 940

Table C49 Derived annual HMV movements in Taranaki.

Year	State Highway and telemetry site			
	3			45
	Tongaporutu	Tariki	Waitotara	Hawera
1997	74 520	166 560	103 290	111 000
1998	77 760	164 160	95 100	102 330
1999	84 000	163 800	76 080	77 700
2000	95 370	183 8870	106 590	97 470
2001	95 880	213 600	127 920	100 170
2002	105 300	223 200	130 650	101 520
2003	190 080	207 900	144 480	102 870
2004	105 570	242 700	165 120	114 900

Table C50 Derived annual HMV movements in the Manawatu/Wanganui region.

Year	State Highway and telemetry site						
	1N			2	3	4	
	Hihitahi	Sanson	Ohau	Norsewood	Manawatu Gorge	Horopito	Upokongaro
1997	169 260	330 900	273 420	141 180	176 400	53 460	39 060
1998	178 080	300 780	283 290	131 235	157 950	52 560	40 425
1999	187 740	310 770	293 265	138 255	166050	51 810	47 400
2000	153 740	342 000	315 360	149 940	184 500	59 040	51 840
2001	129300	346 500	380 700	161 550	212 190	58 080	44 640
2002	145 860	354 900	388 800	163 800	222 190	67 080	49 680
2003	212 850	390 720	400 410	178 200	225 720	72 930	40 740
2004	231 840	396 000	404 460	179 100	228 960	90 450	52 920

Table C51 Derived annual HMV movements in the Wellington region.

Year	State Highway and telemetry site					
	1N		2			58
	Pukerua Bay	Ngauranga Gorge	Clareville	Rimutaka	Ngauranga Gorge	Pauatahunui
1997	309 150	230 940	134 111	63 000	249 360	99 900
1998	478 560	237 420	138 210	53 760	251 010	103 410
1999	323 250	244 080	121 350	56 400	253 440	70 500
2000	256 680	372 150	142 560	59 640	324 000	105 570
2001	254 040	255 720	150 840	72 750	383 490	108 000
2002	259 080	391 140	156 600	74 700	388 260	111 600
2003	799 200	529 560	321 480	166 560	264 600	230 940
2004	395 280	263 520	206 220	78 600	395 820	118 440

Table C52 Derived annual HMV movements in the Tasman/Nelson and Marlborough regions.

Year	State Highway and telemetry site		
	6		
	Hira	Stoke	Murchison
1997	79 200	277 729	48 240
1998	82 830	308 934	49 320
1999	87 450	317 978	52 740
2000	91 080	343 183	58 500
2001	113 820	365 000	59 670
2002	126 840	293 700	64 350
2003	152 130	481 200	82 560
2004	166 640	424 830	58 080

Table C53 Derived annual HMV movements in Canterbury.

Year	State Highway and telemetry site					
	1S				7	73
	Kaikoura	Dunsandel	Timaru	St Andrews	Lewis Pass	Springfield
1997	64 800	228 780	279 000	164 160	43 425	27 300
1998	68 040	248 400	285 000	180 960	45 450	28 320
1999	70 785	283 920	279 000	228 960	45 900	27 720
2000	87 360	300 690	319 935	227 520	47 250	30 480
2001	104 160	290 940	340 560	266 760	60 480	37 260
2002	180 480	328 440	349 380	292 980	114 750	44 100
2003	83 520	299 520	420 210	190 800	27 810	41 850
2004	105 420	358 800	434 490	244 800	49 140	54 450

Table C54 Derived annual HMV movements on the West Coast.

Year	State Highway and telemetry site		
	6		7
	Punakaiki	Chesterfield	Ahaura
1997	17 640	53 730	35 100
1998	20 115	54 270	36 075
1999	18 000	55 350	32 010
2000	31 200	63 300	35 640
2001	21 360	57 510	52 380
2002	20 160	70 800	41 160
2003	31 320	96 330	55 080
2004	23 280	78 300	47 040

Table C55 Derived annual HMV movements in Otago.

Year	State Highway and telemetry site		
	1S		8
	Burnside	Milton	Alexandra
1997	301 950	140 400	38 640
1998	301 650	150 900	39 600
1999	303 750	155 138	41 280
2000	300 450	159 060	47 709
2001	300 750	194 040	49 410
2002	336 300	208 080	52 110
2003	366 750	213 120	48 960
2004	453 420	251 580	56 160

Table C56 Derived annual HMV movements in Southland.

Year	State Highway and telemetry site		
	1S		6
	Gore	Invercargill	Winton
1997	93 690	94 095	82 920
1998	96 255	93 960	86 280
1999	110 400	93 285	89 400
2000	123 123	91 998	90 144
2001	137 880	99 180	108 540
2002	141 840	104 220	101 520
2003	128 840	104 850	102 000
2004	131 340	105 120	117 990

C5 Total annual vehicle movements

Table C57 Total annual vehicle movements in Northland.

Year	State Highway and telemetry site	
	1N	
	Kawakawa	Wellsford
1997	1 486 500	2 029 500
1998	1 275 000	1 768 750
1999	1 295 000	1 817 500
2000	1 315 000	1 785 000
2001	1 337 500	1 925 000
2002	1 415 000	2 030 000
2003	1 410 000	2 162 500
2004	1 502 500	2 257 500

Table C58 Total annual vehicle movements in the Auckland region.

Year	State Highway and telemetry site				
	1N				
	Hadfields Beach	Auckland Harbour Bridge	Panama Road	Drury	Bombay
1997	3 985 500	43 320 000	30 222 000	13158 000	7 965 000
1998	3 150 000	37 325 000	25 670 000	11 107 500	6 826 250
1999	3 552500	37 762 500	26 050 000	11 400 000	7 287 500
2000	3 742 500	38 790 000	26 155 000	12 297 500	7 985 000
2001	3 862 500	37 652 500	26 430 000	11 767 500	7 930 000
2002	4 032 500	38 815 000	27 235 000	12 175 000	7 925 000
2003	4 200 000	40 740 000	27 772 500	13 322 500	8 130 000
2004	4 332 500	40 497 500	27 950 000	13 975 000	8 555 000

Table C59 Total annual vehicle movements in Waikato.

Year	State Highway and telemetry site									
	1N				2		3	25A	27	32
	Taupiri	Karapiro	Lichfield	Hallets Bay	Mangatawhiri	Waihi	Te Kuiti	Hikuae	Kaihere	West Lake Taupo
1997	4 650 000	3 448 500	2 499 000	1 515 000	3 310 500	1 890 000	1 051 500	730 500	1 228 500	162 000
1998	3 997 500	3 031 250	1 972 500	1 347 500	2 893 750	1 605 000	857 500	692 500	1 065 000	163 750
1999	4 092 500	3 100 000	1 950 000	1 312 500	2 985 000	1 673 750	911 250	787 500	1 105 000	168 750
2000	4 110 000	3 082 500	2 002 500	1 350 000	3 277 500	1 742 500	917 500	750 000	1 125 000	167 500
2001	4 190 000	3 225 000	2 247 500	1 292 500	3 052 500	1 630 000	932 500	765 000	1 152 500	167 500
2002	4 257 500	3 335 000	2 290 000	1 375 000	3 197 500	1 707 500	962 500	752 500	1 175 000	187 500
2003	4 475 000	3 455 000	2 277 500	1 387 500	3 375 000	1 795 000	1 007 500	847 500	1 200 000	172 500
2004	4 742 500	3 560 000	2 292 500	1 445 000	3 410 000	1 857 500	1 045 000	845 500	1 205 000	175 000

Table C60 Total annual vehicle movements in Bay of Plenty.

Year	State Highway and telemetry site							
	2		5		29	30		33
	Te Puna	Onhinepanea	Tarukenga	Waipa	Kaimai	Te Ngae (Rotorua)	Lake Rotoma	Paengaroa
1997	3 441 000	1 176 000	1 314 000	1 815 000	1 756 500	9 631 500	856 500	1 291 500
1998	2 995 000	961 250	1 116 250	1 467 500	1 556 250	8 170 000	721 250	1 040 000
1999	3 157 500	997 500	1 155 000	1 502 500	1 630 000	8 185 000	698 125	1 067 500
2000	3 152 500	1 122 500	1 162 500	1 592 500	1 677 500	8 052 500	675 000	1 052 500
2001	3 290 000	1 042 500	1 205 000	1 665 000	1 825 000	8 405 000	697 500	1 075 000
2002	3 477 500	1 100 000	1 265 000	1 757 500	1 950 000	8 552 500	720 000	1 087 500
2003	3 642 500	1 140 000	1 292 500	1 815 000	2 165 000	8 797 500	737 500	1 090 000
2004	3 827 500	1 177 500	1 325 000	1 865 000	2 232 500	8 857 500	750 000	1 162 500

Table C61 Total annual vehicle movements in the Gisborne region.

Year	State Highway and telemetry site
	2
	Ormond
1997	658 500
1998	562 500
1999	585 000
2000	605 000
2001	580 000
2002	605 000
2003	625 000
2004	622 500

Table C62 Total annual vehicle movements in Hawkes Bay.

Year	State Highway and telemetry site		
	2	5	50
	Tangoio	Te Pohue	Napier South
1997	471 000	663 000	3 487 500
1998	410 000	575 000	3 133 750
1999	433 750	613 750	3 630 000
2000	445 000	625 000	3 970 000
2001	437 500	675 500	4 052 500
2002	450 000	707 500	4 300 000
2003	485 000	717 500	4 652 500
2004	500 000	735 000	4 957 500

Table C63 Total annual vehicle movements in Taranaki.

Year	State Highway and telemetry site			
	3			45
	Tongaporutu	Tariki	Waitotara	Hawera
1997	621 000	2 082 000	939 000	1 110 000
1998	405 000	1 710 000	792 500	947 500
1999	437 500	1 706 250	792500	925 000
2000	467 500	1 702 500	807 500	902 500
2001	470 000	1 780 000	820 000	927 500
2002	487 500	1 860 000	837 500	940 000
2003	505 000	1 925 000	860 000	952 500
2004	517 500	2 022 500	860 000	957 500

Table C64 Total annual vehicle movements in the Manawatu/Wanganui region.

Year	State Highway and telemetry site						
	1N			2	3	4	
	Hihitahi	Sanson	Ohau	Norsewood	Manawatu Gorge	Horopito	Upokongaro
1997	1 209 000	3 309 000	3 906 000	1 086 000	1 764 000	486 000	558 000
1998	1 060 000	2 785 000	3 372 500	841 250	1 462 500	365 000	481 250
1999	1 117 500	2 877 500	3 491 250	886 250	1 537 500	392 500	493 750
2000	1 065 000	2 850 000	3 285 000	892 500	1 537 500	410 000	480 000
2001	1 077 500	2 887 500	3 525 000	897 500	1 607 500	440 000	465 000
2002	1 015 000	2 957 500	3 600 000	975 000	1 682 500	430 000	460 000
2003	1 182 500	2 960 000	3 707 500	990 000	1 710 000	467 500	485 000
2004	1 207 500	3 000 000	3 745 000	995 000	1 590 000	502 500	490 000

Table C65 Total annual vehicle movements in the Wellington region.

Year	State Highway and telemetry site					
	1N		2			58
	Pukerua Bay	Ngauranga Gorge	Clareville	Rimutaka	Ngauranga Gorge	Pauatahunui
1997	6 183 000	11 547 000	2 414 000	1 260 000	12 468 000	3 330 000
1998	4 985 000	9 892 500	2 032 500	1 120 000	10 458 750	2 287 500
1999	5 387 500	10 170 000	2 022 500	1 175 000	10 560 000	2 937 500
2000	5 347 500	10 337 500	1 980 000	1 242 500	10 800 000	2 932 500
2001	5 292 500	10 655 000	2 095 000	1 212 500	10 652 500	3 000 000
2002	5 397 500	10 865 000	2 175 000	1 245 000	10 785 000	3 100 000
2003	5 550 000	11 032 500	2 232 500	1 262 500	11 025 000	3 207 500
2004	5 490 000	10 980 000	2 455 000	1 310 000	10 995 000	3 290 000

Table C66 Total annual vehicle movements in the Tasman/Nelson and Marlborough regions.

Year	State Highway and telemetry site		
	6		
	Hira	Stoke	Murchison
1997	720 000	4 371 000	402 000
1998	627 500	4 002 500	342 500
1999	662 500	4 362 500	366 250
2000	690 000	4 362 500	375 000
2001	6777 500	4 562 500	382 500
2002	755 000	4 895 000	412 500
2003	792 500	5 012 500	430 000
2004	810 000	5 057 500	440 000

Table C67 Total annual vehicle movements in Canterbury.

Year	State Highway and telemetry site					
	1S				7	73
	Kaikoura	Dunsandel	Timaru	St Andrews	Lewis Pass	Springfield
1997	540 000	1 906 500	5 580 000	1 368 000	289 500	390 000
1998	472 500	1 725 000	4 750 000	1 160 000	252 500	295 000
1999	536 250	1 820 000	4 650 000	1 192 500	255 000	330 000
2000	560 000	1 927 500	4 847 500	1 185 000	262 500	317 500
2001	542 500	1 865 000	4 730 000	1 235 000	240 000	345 000
2002	565 000	1 955 000	4 852 500	1 285 000	382 500	367 500
2003	580 000	2 080 000	5 002 500	1 325 000	257 500	387 500
2004	627 500	2 300 000	5 172 500	1 360 000	292 500	412 500

Table C68 Total annual vehicle movements on the West Coast.

Year	State Highway and telemetry site		
	6		7
	Punakaiki	Chesterfield	Ahaura
1997	220 500	597 000	270 000
1998	186 250	502 500	231 250
1999	187 500	512 500	242 500
2000	200 000	527 500	247 500
2001	222 500	532 500	242 500
2002	210 000	590 000	245 000
2003	217 500	617 500	270 000
2004	242 500	652 500	280 000

Table C69 Total annual vehicle movements in Otago.

Year	State Highway and telemetry site		
	1S		8
	Burnside	Milton	Alexandra
1997	6 039 000	1 404 000	483 000
1998	5 027 500	1 257 500	412 500
1999	5 062 500	1 231 250	430 000
2000	5 007 500	1 205 000	441 750
2001	5 012 500	1 347 500	457 500
2002	5 605 000	1 445 000	482 500
2003	6 112 500	1 480 000	510 000
2004	6 297 500	1 497 500	520 000

Table C70 Total annual vehicle movements in Southland.

Year	State Highway and telemetry site		
	1S		6
	Gore	Invercargill	Winton
1997	1 041 000	3 136 500	1 036 500
1998	891 250	2 610 000	898 750
1999	920 000	2 591 250	931 250
2000	932 750	2 555 500	939 000
2001	957 500	2 755 000	1 005 000
2002	985 000	2 985 000	1 057 500
2003	970 000	2 912 500	1 062 500
2004	995 000	2 920 000	1 092 500

Appendix D GDP by region

The figures presented in Table D1 were sourced from the Statistics New Zealand website (Statistics New Zealand 2007).

Table D1 Summary of regional GDP for 1997–2004.

Region	GDP ($000)							
	1997	1998	1999	2000	2001	2002	2003	2004
Northland	$3,410,071	$3,393,423	$3,490,252	$3,679,135	$3,827,087	$4,036,595	$4,131,621	$4,367,098
Auckland	$31,846,298	$32,456,994	$34,111,772	$35,415,572	$35,980,778	$37,393,535	$38,973,847	$40,908,214
Waikato	$9,103,103	$9,064,058	$9,382,823	$9,774,471	$10,142,617	$10,586,253	$10,823,876	$11,456,173
Bay of Plenty	$5,723,481	$5,881,164	$6,235,188	$6,553,944	$6,773,184	$7,096,593	$7,393,824	$7,827,891
Gisborne	$983,791	$997,066	$1,013,037	$1,036,622	$1,068,660	$1,116,052	$1,145,953	$1,189,038
Hawkes Bay	$3,496,630	$3,423,838	$3,527,483	$3,676,397	$3,800,059	$4,043,653	$4,181,195	$4,413,662
Taranaki	$2,601,722	$2,576,056	$2,624,844	$2,593,347	$2,665,925	$2,822,124	$2,848,870	$2,975,257
Manawatu/ Wanganui	$5,354,640	$5,210,227	$5,373,171	$5,484,869	$5,699,281	$5,937,726	$6,053,417	$6,214,062
Wellington	$11,370,995	$11,266,270	$11,863,397	$12,272,431	$12,445,359	$12,815,122	$13,101,833	$13,250,120
Tasman/ Nelson	$1,143,382	$1,121,718	$1,186,450	$1,253,643	$1,315,988	$1,443,511	$1,521,220	$1,651,719
Marlborough	$2,189,379	$2,148,595	$2,271,200	$2,382,210	$2,469,234	$2,614,123	$2,769,965	$2,985,213
Canterbury	$12,075,758	$11,890,002	$12,389,086	$12,719,079	$13,078,410	$13,843,857	$14,286,444	$15,142,170
West Coast	$964,132	$923,811	$926,382	$956,633	$942,042	$986,397	$1,007,338	$1,038,270
Otago	$4,603,293	$4,501,864	$4,647,275	$4,746,629	$4,961,261	$5,278,513	$5,505,105	$5,813,385
Southland	$2,422,326	$2,349,915	$2,419,639	$2,434,019	$2,571,116	$2,760,945	$2,865,492	$2,938,730

Appendix E Population by region

Table E1 Population of New Zealand regions in 1997–2004 (Statistics New Zealand 2007).

Region	Estimated resident population							
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Northland	141 700	143 300	144 400	145 300	144 400	1454 500	146 600	147 600
Auckland	1 138 600	1 159 600	1 175 700	1 193 000	1 216 900	1 253 850	1 290 800	1 316 700
Waikato	362 100	365 200	366 700	368 000	369 800	373 800	377 800	381 900
Bay of Plenty	234 100	238 300	240 900	243 000	246 900	250 450	254 000	257 500
Gisborne	46,800	46,700	46,600	46,500	45,500	45,350	45,200	44,900
Hawkes Bay	146,300	146,200	145,600	145,200	147,300	147,900	148,500	149,100
Taranaki	107,700	106,800	105,500	104,300	105,700	105,700	105,700	105,400
Manawatu/ Wanganui	232,900	231,700	230,400	229,100	227,500	227,400	227,300	227,100
Wellington	427,200	428,700	429,100	429,700	440,200	445,900	451,600	456,900
Tasman/ Nelson	39,400	39,700	39,900	40,000	40,700	41,200	41,700	42,300
Marlborough	80,400	80,900	81,300	81,900	85,300	87,200	89,100	91,100
Canterbury	33,000	32,900	32,600	32,300	31,100	30,900	30,700	30,600
West Coast	483,900	487,300	489,800	491,800	496,700	504,700	512,700	520,500
Otago	188,900	188,200	187,500	187,300	188,300	190,550	192,800	195,000
Southland	97,300	95,700	94,000	92,900	93,300	93,500	93,700	93,600

Appendix F Traffic counts

The following abbreviations have been used for the sections of road:

- NA: Northland–Auckland
- AK: Auckland–Waikato
- KB: Waikato–Bay of Plenty
- KH: Waikato–Hawkes Bay
- KM: Waikato–Manawatu/Wanganui
- KT: Waikato–Taranaki
- BG: Bay of Plenty–Gisborne
- BM: Bay of Plenty–Manawatu/Wanganui
- GH: Gisborne–Hawkes Bay
- HM: Hawkes Bay–Manawatu/Wanganui
- TM: Taranaki–Manawatu/Wanganui
- MW: Manawatu/Wanganui–Wellington
- WR: Wellington–Marlborough
- RE: Marlborough–Tasman/Nelson
- RC: Marlborough–Canterbury
- RL: Marlborough–West Coast
- EL: Tasman/Nelson–West Coast
- EC: Tasman/Nelson–Canterbury
- CL: Canterbury–West Coast
- CO: Canterbury–Otago

Table F1 Annual maximum heavy vehicle traffic counts 1997–2004 (TNZ 2007).

Route	Maximum heavy vehicle traffic count							
	1997	1998	1999	2000	2001	2002	2003	2004
NA	239 103	226 800	255 780	314 370	324 450	388 730	352 800	311 940
AK	1511100	1 540200	156300	1569300	1585800	1634100	1666350	167700
KB	310 365	327 375	334 800	369 900	387 000	400 200	497 520	427 200
KH	310 365	327 375	334 800	369 900	387 000	400 200	497 520	427 200
KM	310 365	311 380	351 000	384 480	404 550	412 200	497 520	440 160
KT	126 180	123 480	133 220	143 130	145 470	161 700	193 440	188 100
BG	188 160	161 490	167 580	323 280	175 140	198 000	205 200	197 820
BM	385 260	392 160	392 880	386 520	403 440	410 520	633 420	531 450
GH	61 230	68 880	78 075	90 780	94 500	97 200	98 940	900 000
HM	209 250	188 025	217 800	238 200	243 150	258 000	334 980	356 940
TM	209 250	188 025	217 800	238 200	243 150	258 000	334 980	356 940
MW	309 150	478 560	323 250	372 150	380 700	391 140	799 200	404 460
WR	26 563	32 422	38 281	444 141	50 000	55 859	61 719	67 578
RE	79 200	82 830	87 450	91 080	113 820	126 840	152 160	116 640
RC	64 800	68 040	70 785	87 360	104 160	108 480	83 520	105 420
RL	48 240	49 320	52 740	58 500	59 670	64 350	82 560	58 080
EL	48 240	49 320	52 740	58 500	59 670	64 350	82 560	58 080
EC	64 800	68 040	70 785	87 360	104 106	108 480	3 520	105 420
CL	27 300	28 320	27 720	30 480	37 260	44 100	41 850	54 450
CO	279 000	285 000	283 920	319 935	340 560	349 380	420 210	434 490

Table F2 Annual minimum heavy vehicle traffic count totals 1997–2004 (source TNZ 2007).

Route	Minimum heavy vehicle traffic count							
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
NA	118 920	122 400	132 090	142 020	144 450	161 310	169 200	162 270
AK	511 500	527 670	491 100	542 520	502 800	510 900	689 100	626 010
KB	210 780	205 425	215160	241 560	219 000	140 400	311 760	321 480
KH	92 820	89 700	103 110	112 500	134 130	151 800	189 420	141 120
KM	169 260	177 870	173 250	153 360	129 300	145 860	212 850	225 420
KT	74 520	77 760	84 000	95 370	95 880	105 300	109 080	105 570
BG	65 850	67 500	70 200	72 600	69 600	72 600	90 000	82 170
BM	167 895	149 760	153 720	153 360	129 300	145 860	212 850	181 350
GH	61 230	68 880	78 075	90780	94 500	97 200	98 940	90 000
HM	141 180	131 235	138 255	149 940	161 550	163 800	178 200	179 100
TM	141 180	131 235	138 255	149 940	161 550	163 800	178 200	179 100
MW	230 940	237 420	244 080	256 680	254 040	259 080	400 410	263 520
WR	26 563	32 422	38 281	44 141	50 000	55 859	61 719	97 578
RE	79 200	82 830	87 450	91 080	113 820	126 840	152 160	116 640
RC	64 800	68 040	70 785	87 360	104 160	08 480	83 520	105 420
RL	17 640	20 115	18 000	31 200	21 360	20 160	31 320	23 280
EL	17 640	20 115	18 000	31 200	21 360	20 160	31 320	23 280
EC	64 800	68 040	70 785	87 360	104 160	108 480	83 520	105 420
CL	27 300	28 320	27 720	30 480	37 260	44 100	41 850	54 450
CO	164 160	180 960	228 960	227 520	266 760	292 980	190 800	244 800

Table F3 Average heavy vehicle traffic count totals for 1997–2004 (source: TNZ 2007).

Route	Average heavy vehicle traffic count							
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
NA	179 025	174 600	193 935	228 195	243 450	250 020	261 000	237 105
AK	935 040	988 335	1005750	1041645	1018680	1066200	1154735	1235393
KB	260 573	266 400	274 980	305 730	303 000	270 300	404 640	374 340
KH	175 736	174 030	181 230	199 763	216 383	228 930	302 250	236 160
KM	240 326	253 676	261 698	277 560	284 498	297 315	363 015	331 155
KT	100 350	100 620	107 610	119 250	120 675	133 500	151 260	146 835
BG	127 005	114 495	118 890	197 940	122 370	135 300	147 600	139 995
BM	217 143	211 272	213 972	219 534	226 056	236 196	324 660	274 296
GH	61 230	68 880	78 075	90 780	94 500	97 200	98 940	90 000
HM	175 610	159 070	174 035	190 880	205 630	214 630	246 300	255 000
TM	175 610	159 070	174 065	190 880	205 630	214 630	246 630	255 000
MW	271 170	333 090	286 865	314 730	296 820	346 340	576 390	354 420
WR	26 563	32 422	38 281	44 141	50 000	55 859	61 719	67 578
RE	79 200	82 830	87 450	91 080	113 820	126 840	152 160	116 640
RC	64 800	68 040	70 785	87 360	104 160	108 480	83 520	105 420
RL	32 940	34 718	35 370	44 850	40 515	42 255	56 940	40 680
EL	32 940	34 718	35 370	44 850	40 515	42 255	56 940	40 680
EC	64 800	68 040	70 785	87 360	104 160	108 480	83 520	105 420
CL	27 300	28 320	27 720	30 480	37 260	44 100	41 850	54 450
CO	223 980	238 120	263 960	282 715	299 420	323 600	303 510	346 030

Appendix G Detailed regression results

Table G1 Detailed regression results for GDP (minimum).

Year	Variable	Coefficients	Standard error	T-statistic	Significance (T)	Significance (p)	p significance	Other
1997	Constant	-2.32	2.54	-0.91	–	0.37	–	R^2=73.2
	Ln(*GDP)*,	0.39	0.11	3.45	1%	0.00	1%	Adj R^2=68.5
	Ln*(GDP)j*	0.55	0.11	4.83	1&	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.53	0.26	-2.02	10%	0.06	10%	Significant
1998	Constant	-1.66	2.34	-0.71	–	0.49	–	R^2=74.4
	Ln(*GDP)*,	0.38	0.11	3.62	1%	0.00	1%	Adj R^2=69.9
	Ln*(GDP)j*	0.52	0.10	4.93	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.50	0.24	-2.05	10%	0.06	10%	Significant
1999	Constant	-2.14	2.42	-0.89	–	0.39	–	R^2=74.0
	Ln(*GDP)*,	0.39	0.11	3.61	1%	0.00	1%	Adj R^2=69.4
	Ln*(GDP)j*	0.53	0.11	4.99	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.46	0.25	-1.83	10%	0.08	10%	Significant
2000	Constant	0.01	2.09	0.00	–	1.00	–	R^2=74.9
	Ln(*GDP)*,	0.32	0.09	3.37	1%	0.00	1%	Adj R^2=70.5
	Ln*(GDP)j*	0.48	0.09	5.16	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.45	0.22	-2.09	5%	0.05	10%	Significant
2001	Constant	-0.76	2.13	-0.36	–	0.73	–	R^2=76.5
	Ln(*GDP)*,	0.32	0.10	3.36	1%	0.00	1%	Adj R^2=72.4
	Ln*(GDP)j*	0.52	0.09	5.54	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.46	0.22	-2.06	10%	0.05	10%	Significant
2002	Constant	-1.33	2.28	-0.58	–	0.57	–	R^2=73.5
	Ln(*GDP)*,	0.34	0.10	3.27	1%	0.00	1%	Adj R^2=68.8
	Ln*(GDP)j*	0.53	0.10	5.32	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.32	0.23	-1.37	20%	0.19	20%	Significant
2003	Constant	-0.30	2.27	-0.13	–	0.90	–	R^2=75.0
	Ln(*GDP)*,	0.38	0.10	3.69	1%	0.00	1%	Adj R^2=70.6
	Ln*(GDP)j*	0.45	0.10	4.61	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.62	0.23	-2.67	5%	0.02	5%	Significant
2004	Constant	-2.07	2.05	-1.01	–	0.33	–	R^2=79.8
	Ln(*GDP)*,	0.42	0.09	4.55	1%	0.00	1%	Adj R^2=76.2
	Ln*(GDP)j*	0.50	0.09	5.71	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.43	0.21	-2.08	10%	0.05	10%	Significant

*T: travel time

Table G2 Detailed regression results for GDP (average).

Year	Variable	Coefficients	Standard error	T-statistic	Significance (T)	Significance (p)	p significance	Other
1997	Constant	-2.21	3.03	-0.73	–	0.48	–	R^2=65.5
	Ln(*GDP),*	0.46	0.14	3.36	1%	0.00	1%	Adj R^2=59.4
	Ln*(GDP)j*	0.50	0.14	3.67	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.54	0.31	-1.73	10%	0.10	20%	Significant
1998	Constant	-2.11	2.83	-0.75	–	0.47	–	R^2=68.3
	Ln(*GDP),*	0.46	0.13	3.60	1%	0.00	1%	Adj R^2=62.7
	Ln*(GDP)j*	0.49	0.13	3.87	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.53	0.30	-1.81	10%	0.09	10%	Significant
1999	Constant	-1.96	2.80	-0.70	–	0.49	–	R^2=68.1
	Ln(*GDP),*	0.45	0.13	3.59	1%	0.00	1%	Adj R^2=62.5
	Ln*(GDP)j*	0.49	0.12	3.91	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.51	0.29	-1.73	10%	0.10	20%	Significant
2000	Constant	-1.02	2.83	-0.36	–	0.72	–	R^2=64.6
	Ln(*GDP),*	0.42	0.13	3.31	1%	0.00	1%	Adj R^2=58.3
	Ln*(GDP)j*	0.46	0.13	3.65	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.45	.030	-1.54	20%	0.14	20%	Significant
2001	Constant	-1.40	2.42	0.58	–	0.57	–	R^2=72.6
	Ln(*GDP),*	0.40	0.11	3.68	1%	0.00	1%	Adj R^2=67.8
	Ln*(GDP)j*	0.50	0.11	4.69	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.43	0.25	-1.72	20%	0.10	20%	Significant
2002	Constant	-1.40	2.40	-0.58	–	0.57	–	R^2=72.9
	Ln(*GDP),*	0.42	0.11	3.83	1%	0.00	1%	Adj R^2=72.9
	Ln*(GDP)j*	0.49	0.10	-1.71	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.42	0.25	-1.71	20%	0.10	20%	Significant
2003	Constant	-0.74	2.84	-0.26	–	0.80	–	R^2=66.8
	Ln(*GDP),*	0.45	0.13	3.47	1%	0.00	1%	Adj R^2=61.0
	Ln*(GDP)j*	0.43	0.12	3.52	1%	0.00	1%	Sig F = 0.00
	Ln*(T*)ij*	-0.61	0.29	-2.09	5%	0.05	10%	Significant
2004	Constant	-2.42	2.46	-0.98	–	0.34	–	R^2=74.5
	Ln(*GDP),*	0.50	0.11	4.48	1%	0.00	1%	Adj R^2=70.0
	Ln*(GDP)j*	0.47	0.11	4.44	1%	0.00	1%	Sig F =0.00
	Ln*(T*)ij*	-0.46	0.25	-1.85	10%	0.08	10%	Significant

*T: travel time

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