Prediction of freight growth by 2020 and rail's ability to share the load

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ABSTRACT : This project predicted the overall demand for freight transport in New Zealand by 2020. Using a variety of data sources, freight growth in the nation's regions was also estimated. A secondary objective was to estimate the proportion of the freight growth that could be transported by rail.

Between 1997 and 2005, the number of heavy vehicles in New Zealand has grown steadily (55% increase for trucks) with a corresponding increase in heavy vehicle kilometres (HVkm) of 42%. Yearly heavy vehicle travel has been increasing at approximately 1.4 times national Real gross domestic product (RGDP) growth. If current trends persist, HVkms are predicted to grow by approximately 76% by 2020, and RUC revenue (which accounts for payload) is expected to grow by 91%.

In comparison, the ratio of HVkm to RGDP (transport intensity) in many other countries is much lower. This may be attributable to New Zealand's relatively large primary production sector and relatively low value goods. Also countries with lower transport intensity may manufacture higher value goods and have relatively large service sectors.

Within New Zealand, large increases in truck travel are expected within the Auckland, Waikato and Bay of Plenty triangle as well as Canterbury. This expectation is driven by the relatively large amount of truck travel that exists within these regions along with their relatively strong economic performance.

There are a number of factors that may cause variation from these predictions including long-term changes in the structure of the New Zealand economy, changes in the structure in the New Zealand transport system, traffic congestion and environmental considerations.

Using three different scenarios it was predicted that rail freight has the potential to triple by 2020 but this will only increase its modal share from approximately 13% to 20%.

INTRODUCTION

Some time ago, Transport Engineering Research NZ (TERNZ) completed an analysis of the profile of New Zealand's heavy vehicle fleet (Baas and Arnold 1999). Since then, a number of TERNZ reports have up-dated this information (Bolitho et al 2003, Mueller and Baas 2004, Mackie and Baas 2006) and a model has been developed that describes the relationship between road heavy vehicle movements (using Road User Charges (RUC) data) and Real Gross Domestic Product (RGDP). From this previous work is has become evident that based on the growth in road heavy vehicle kilometres (HVkm) of the past nine years, New Zealand can expect significant growth in road heavy vehicle traffic by 2020. This finding has significant implications for the following areas:

- Infrastructure planning and development for freight
- Heavy vehicle workforce requirements
- Safety of road users
- Environmental effects
- Impacts on communities

Following on from this finding, a preliminary analysis of the proportion of freight that might be transported by rail in the future was then conducted (Mackie and Baas 2006a). The main findings of the two most recent reports *Prediction of New Zealand's Freight Growth by 20*20 (Mackie and Baas 2006) and *The contestability of New Zealand's Road freight task by rail* (Mackie and Baas 2006a) will be presented in this paper along with an up-date of the TERNZ freight model using the latest road freight movements and RGDP data.

Confirmation of relationship between heavy vehicle traffic and RGDP

A relationship between HVkm and real gross domestic product[1] (RGDP) was reported by Bolitho et al. (2003). This data were updated to include data from 2002-2006 inclusive[2] (Table 1). One change to the methodology used to process these updated data was to calculate the total number of HVkm's travelled using only trucks, whereas previously the sum of all trucks and trailers were used. While it is accepted that over time there may be a change in the distribution of truck-trailer types, the main predictor of overall heavy vehicle traffic volume is the distance travelled by trucks, as each trip must include a truck, which may or may not be towing one or two trailers. This change in methodology resulted in an improvement in the correlation (R^2) between heavy vehicle movements and RGDP from $R^2 = 0.73$ using truck and trailer data to $R^2 = 0.90$ using truck-only data. A correlation coefficient (R^2) that equals 1 represents a perfect linear relationship between two variables, while 0 represents no relationship at all between two variables.

By adding the 2002-2005 data, a further improvement in the correlation between HVkm and RGDP was observed ($R^2 = 0.985$), with the 'transport factor' (T) reducing slightly to 1.42.

[1] GDP is the total market value of goods and services produces within a given period after deducting the cost of goods utilised in the process of production. RGDP is expressed as the dollar values of a particular year. RGDP is effectively GDP after adjustment for inflation (NZ Institute of Economic Research http://www.nzier.org.nz/SITE_Default/SITE_economics_explained/GDP.asp).

[2] 1997-2006 RGDP data: Statistics New Zealand: http://www.stats.govt.nz/products-and-services/info-releases/gdp-info-releases.htm

Previously, Bolitho et al. (2003) had reported a transport factor of 1.53. The addition of the 2006 data gives a similar correlation, with T decreasing slightly further to 1.37 (Figure 1.)

	RGDP (million $)	HVkm (million)
1997	95,947	2,042
1998	98,138	2,044
1999	98,557	2,171
2000	103,795	2,257
2001	106,009	2,367
2002	109,852	2,511
2003	114,851	2,619
2004	118,886	2,810
2005	123,495	2,907
2006	126,009	2,932

Table 1. Real Gross Domestic Product (RGDP) and heavy vehicle kilometres (HVkm) traveled (both calendar years) between 1997 and 2006.

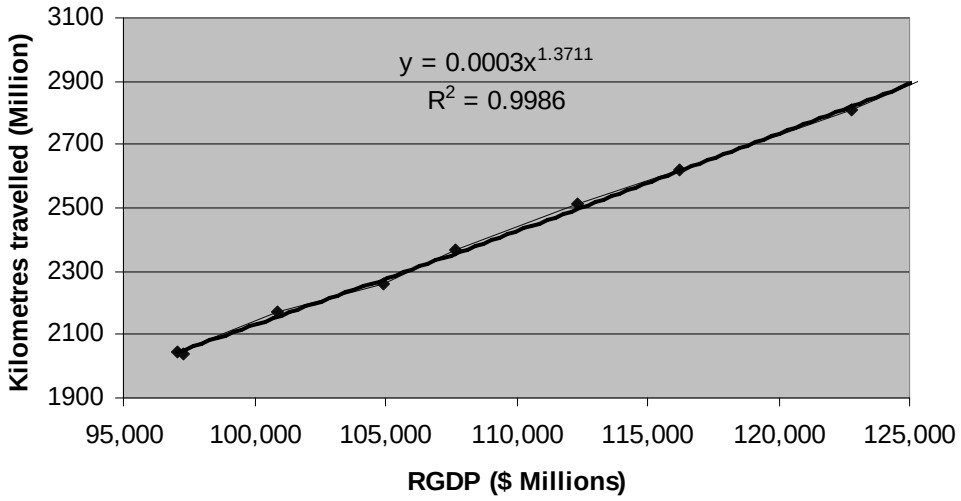

Figure 1. Relationship between HVkm's traveled and real GDP between 1997 and 2006 inclusive.

Using Road User Charges revenue to predict freight growth

Although HVkms are a good predictor of the overall road freight task, changes in the amount of load carried per trip may lead to HVkms underestimating or overestimating the overall road freight task. In order to investigate this, the average load carried in each weight and vehicle type was calculated from the RUC data. Each weight was multiplied by the corresponding total kilometres purchased to give a weighted average load for each RUC vehicle type for the entire truck and trailer fleet. There have been small increases in average loads purchased

over the 1997–2005 period. On average, truck weights purchased have increased 2.2%, trailer weights 5.2% and truck and trailer combined 3.2%.

As a result of these weight increases, RUC revenue, which accounts for vehicle weights purchased, were also analysed. The same methodology that was used for the HVkm vs RGDP model was used to create a model for RUCs purchased vs RGDP.

This model reveals a multiplier (T factor) of 1.51, as opposed to 1.37 that resulted when HVkm and RGDP are compared in any one year. This indicates that heavy vehicle RUC revenue tends to increase 14% faster than HVkm.

Predicted freight growth to 2020

Beyond immediate treasury forecasts, an extrapolation of a reasonable average long-term RGDP can be used with the model that has been presented to give an approximation for the heavy vehicle travel that might be expected by 2020 (Figure 2). This estimate shows that heavy vehicle kms travelled are likely to grow by approximately 76% whereas RUC revenue is likely to grow by approximately 91%. The up-dated estimate for HVkm are lower than the estimate (85%) that was originally published by Mackie et al. (2006) but are well within the limits of confidence that were presented. These estimates are based on a 'business as usual' scenario and do not account for any significant changes in the transport system in the future.

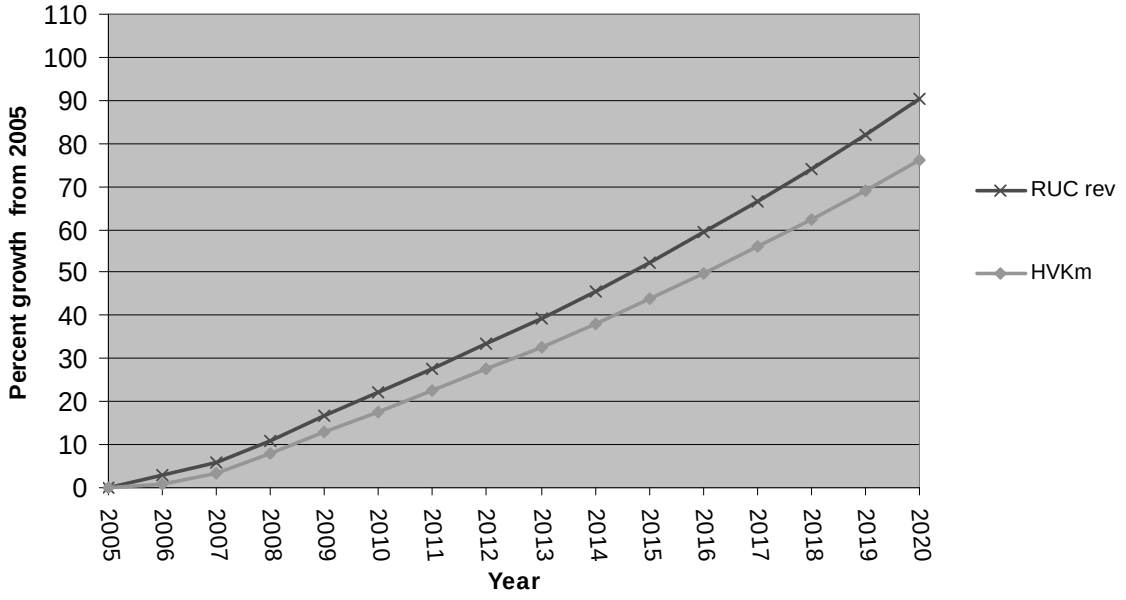

Figure 2. Expected growth in heavy vehicle km and heavy vehicle RUC revenue between 2005 and 2020 using the TERNZ freight model.

New Zealand's heavy vehicle travel trend different to other countries

It appears that the relationship between RGDP and heavy vehicle travel that exists for New Zealand does not exist for many other countries, although a factor of 1.5 has been reported in Europe where a 1% increase in industrial production leads to a 1.5% rise in road transport (Meersman and Van der Voorde 1999). Figure 3 shows the change in heavy vehicle travel (HVkm), the change in RGDP and the change in the ratio HVkm/RGDP for New Zealand between 1997 and 2006[3]. Each variable has been standardised to a base of 100 at 1997 so

[3] Calculated from data used in earlier analysis of HVkm multiplier factor (T).

that their relative changes can be compared. The ratio HVkm/RGDP is often calculated as it gives an indication of 'transport intensity' or the amount of transport that is required to grow the economy of a country by a given amount. As would be expected, because the change in heavy vehicle travel is increasing at a rate of approximately 1.37-1.51 times the change in RGDP, the ratio HVkm/RGDP has also increased between 1997 and 2005. Differently, in the UK[4] heavy vehicle travel (HVkm) has only increased slightly (and more recently decreased) while RGDP has increased steadily (Figure 4). Correspondingly, the ratio HVkm/RGDP has decreased from 100 to 78 between 1997 and 2004. It appears that the UK has been able to grow its economy with disproportionately less growth in heavy vehicle travel.

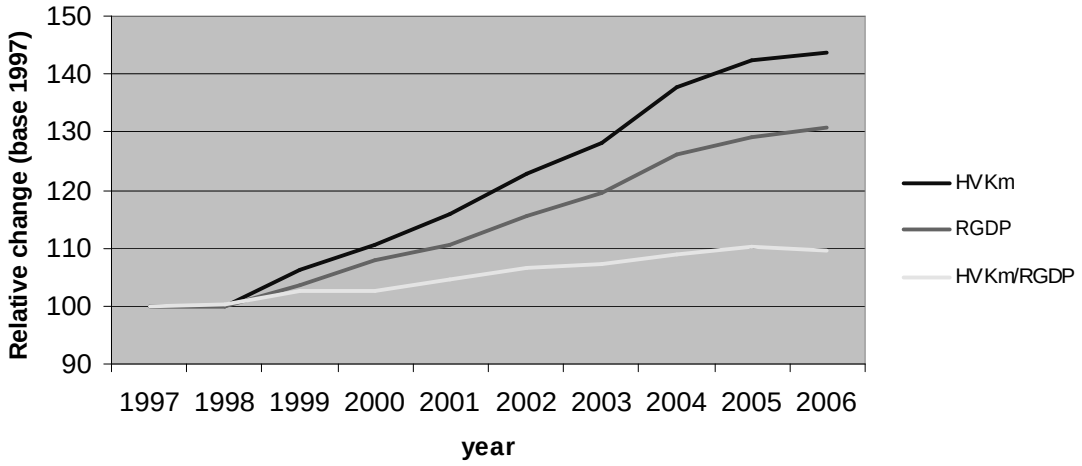

Figure 3. Relative change in heavy vehicle km (HVkm), RGDP and the ratio HVKm/RGDP for New Zealand between 1997 and 2006

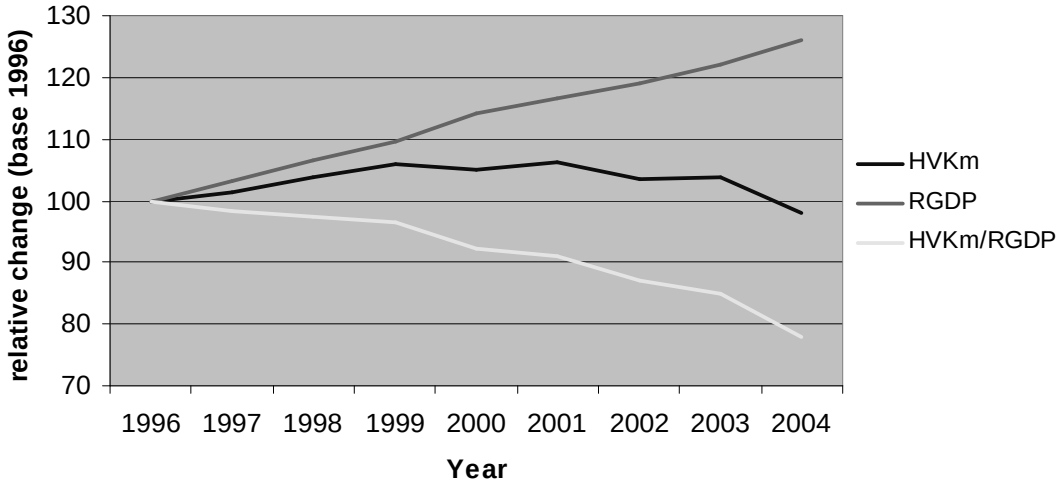

Figure 4. Relative change in heavy vehicle km (HVkm), RGDP and the ratio HVKm/RGDP for the UK between 1996 and 2004.

[4] Data calculated from Department for Transport spreadsheet: Domestic Freight Transport by Mode 1953-2004
http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/divisionhomepage/037806.hcsp

Transport intensity is also lower in the USA, and many countries in Europe, but is higher in Ireland and Spain. There may be a number of factors that contribute to differences in the relationship between RGDP and HVkm for New Zealand and countries such as the UK and USA:

- In New Zealand the agricultural, logging / forestry and fisheries sectors together account for approximately 6-7% of New Zealand's annual RGDP (with the total primary industries accounting for about 10% of national RGDP)[5] whereas in the UK and the USA the agricultural industry (including fisheries and logging / forestry) accounts for approximately 1% of annual RGDP[6, 7]. Conversely, in New Zealand the service sector accounts for approximately 68% of RGDP while in the UK and the USA, the service sector accounts for approximately 73% and 78% respectively. Because the UK and the USA have a greater reliance on the service sector for their economic growth, it would be logical that there would be a relatively smaller growth in transport in order to grow their economies compared with New Zealand. It should also be noted that the New Zealand economy is gradually moving closer to the economic profiles of the UK and the USA (Figure 5). Since 1988 the main production industries (agriculture, forestry / logging and fisheries) have remained static in terms of their share of RGDP, while the manufacturing industry has reduced by approximately 3.7%. In contrast, the services sector has increased its share of RGDP by 4%.

- In the USA there has been an increased production of high-value and light-weight goods[8]. This would mean that greater value would be given to freight loads, allowing RGDP to grow faster than transport. This may also be the case for the UK.

- The growth in primary production output in New Zealand in recent years has come from areas that are more remote from processing facilities and markets than the traditional production areas. Examples include growth of dairy farming in Southland and Canterbury and the maturing of forests in Northland and the East Coast. Thus the average freight distance for the additional production is greater than average freight distance for the pre-existing production

- There may also be operational differences between the freight transport sectors of New Zealand and the UK and USA. However, there appears to be no literature available that specifically addresses this.

[5] Statistics New Zealand. Composition of Gross Domestic Product (RGDP) http://www.stats.govt.nz
[6] Bureau of Economic Analysis. Annual Industry Accounts. Revised estimates for 2002-2004. http://www.bea.doc.gov/bea/ARTICLES/2005/12December/1205_indyAccts.pdf
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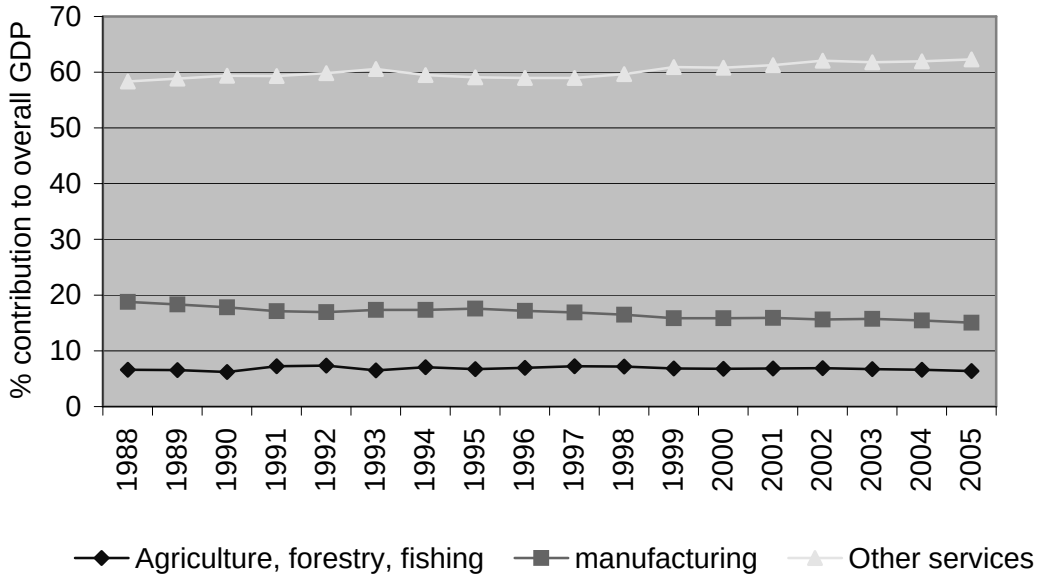

Figure 5. Percent contribution of the major sectors to overall RGDP in New Zealand.

While the economic profile of New Zealand may never be the same as larger countries such as the UK and USA and may always have a greater reliance on transport due to our relatively large primary sector, it might be that the current relationship between RGDP and heavy vehicle travel changes in the future as New Zealand moves towards a more service and value-added economy. Alternatively, New Zealand is increasingly becoming a distribution centre for overseas manufactured products. Large storage and distribution centres that are emerging in some of New Zealand's main centres create a large transport requirement, especially in the immediate vicinity of such facilities. Likewise, the possible trend towards port rationalisation means that increasingly, freight will need to be transported longer distances to reach a major port, as opposed to simply travelling to the nearest port.

Prediction of regional heavy vehicle travel to 2020

Regional economic variation

Economic performance and heavy vehicle transport growth have been shown to be closely related. One of the main limitations for using overall economic performance to predict heavy transport growth is that the economies (and therefore the transport growth) in different regions of the country are different. Table 2 shows that the economies of New Zealand's regions have grown between 2.5 and 3.4% per annum between 1996 and 2005[9]. The economic indicators used to estimate regional growth are a composite index of deflated and seasonally adjusted regional economic indicators. This is used as an equivalent of each region's RGDP. Northland, Waikato and the Bay of Plenty have shown the highest growth over this period, while Gisborne, Manawatu-Wanganui and the West Coast of the South Island have shown the lowest growth.

[9] National Bank of New Zealand. http://www.nbnz.co.nz/economics/regional/NBNZ_Composite_Indices_Of_Regional_Economic_Activity.xls

	Average yearly regional economic growth (%) 1996-2005
Northland	3.4
Auckland	2.9
Waikato	3.4
BOP	3.4
Gisborne	2.5
Hawke's Bay	2.8
Taranaki	2.8
Manawatu-Wanganui	2.6
Wellington	3.3
Tasman	3.3
Nelson	3.3
Marlborough	3.3
West Coast	2.8
Canterbury	3.1
Otago	2.9

Table 2. Regional economic growth in New Zealand regions 1996-2005. Note: Tasman, Nelson and Marlborough are identical as they are grouped together by the National Bank for their regional economic reporting.

Estimating regional heavy vehicle travel

The estimated amount of freight (in tonnes) that moves between and within each region has been calculated by Bolland et al. (2005), using 2002 traffic movements as a base for their estimation. Auckland, Waikato and the Bay of Plenty account for over half of all of New Zealand's road and rail freight, and the greatest amount of freight tends to be moved within these regions, with Auckland having the largest intra-regional road freight movement (15,333,000 tonnes per year – based on 2002 volumes). The freight matrix also shows that the bulk of cross-regional freight movement occurs between adjoining regions.

Using the regional freight estimations by Bolland et al. and the regional economic performance statistics provided by the National Bank, the amount of heavy vehicle traffic within each region can be estimated and predicted to 2020 (Figure 6), allowing for the following assumptions:

- That the regional freight tonnages reported by Bolland et al. are directly proportional to the heavy vehicle traffic (HVkm) in each region.
- That the regional freight movements reported by Bolland et al. are accurate (the matrix used to estimate freight movements was based on modelling).
- That each region's annual average economic growth between 1996-2005 will, on average, be the same as annual average growth between 2005-2020.
- That a transport factor (T) of 1.42 exists (HVKm/RGDP)
- That the regional economic indicators used by the National Bank are closely related to regional RGDP.

Figure 6. Regional heavy vehicle travel growth (HVkm) between 2005 and 2020.

It is clear from Figure 6 that, using this method of prediction, Auckland, Waikato, BOP and Canterbury will have much greater absolute increases in heavy vehicle travel than the other regions. While the Waikato can expect heavy vehicle growth of 104% by 2020, Gisborne can only expect growth of 62%. The largest absolute growth in heavy vehicle travel is expected in the Waikato where an increase of 565 million HVkm is expected by 2020. Road User Charges data indicate that on average truck travel distance is approximately 28,000 km (a large combination vehicle typically travels 70,000 km or more per year while the much more numerous urban trucks travel much fewer kms). This would mean that the Waikato region could expect an extra 20,179 heavy vehicle trips per year by 2020.

The Contestability of New Zealand's Road Freight task by rail

New Zealand's freight task is expected to grow significantly by 2020 if the trend of the last ten years continues. Like many countries, the New Zealand government proposes to promote the use of rail freight transport where it is appropriate. However, there is currently very little information available on what proportion of this rapidly growing freight transport task is contestable by rail, which types of freight are suited to rail transport and which regions are able to make greater use of rail to transport freight. This section summarises the findings of Mackie et al. (2006a) which aimed to provide a preliminary estimate of the proportion of the freight task currently transported by road that is contestable by rail and how much of the expected freight growth is contestable by rail. More detail is provided in the report.

One of the challenges of comparing road and rail freight movements is that they tend to be measured differently. It is easiest to use HVkm as a surrogate for road freight (as has been reported in this paper) as the RUC system provides a reasonably accurate estimate of what has been carried (no one would purchase more RUCs than they need to, and there are significant penalties associated with RUC avoidance). Also RUC information is available from a centralised government administered source. On the other hand rail freight is typically measured using tonne-kilometres, and the information is only available from rail operators. Care must be taken when comparing road and rail freight data.

Contrary to popular belief, when compared with other countries, New Zealand makes relatively good use of its railway network. On a tonnage basis, it is estimated that approximately 13% of New Zealand's land freight task is transported by rail (21% on tonne kilometre basis). Some countries have implemented or are in the process of implementing rail freight promotion strategies. Early indications suggest that significant changes to the freight modal share, based on these initiatives, are difficult. In the UK, following rail promotion strategies, a modal share change of approximately 4% in favour of rail has occurred from a relatively low base.

In New Zealand rail freight has the advantage of having relatively little competition for access to tracks by passenger services (although is changing in urban places like Auckland). While this is a major issue for countries like the UK, in New Zealand, inter-regional passenger services are all but non-existent, and rail freight services have relatively un-restricted access.

New Zealand's rail infrastructure and freight transport was compared with a number of other countries and three scenarios were used to estimate the proportion of the current freight task that is contestable by rail:

- **Scenario 1:** Maximum use of 'economically and practically viable' rail links
- **Scenario 2:** Growth in major commodity and freight forwarding rail transport
- **Scenario 3:** Growth in the payload of current rail operations

A further scenario was used to investigate the likely modal share of the 2020 freight task using current growth rates.

Sixty-two out of New Zealand's 74 districts (84%) have a functioning railway line running through them yet only 42% of New Zealand's freight travels between 'rail compatible' regions. Of this proportion, 70% of this freight is estimated to be accessible to a suitable railway line, and a further 70% of this freight is considered not to be 'time sensitive'. When all of these factors are combined, 20.6% of all freight could potentially travel by rail within New Zealand.

Traditionally, rail is best suited to carrying large consignments of bulk goods where speed of delivery is not critical (although time-sensitive deliveries between Auckland and Christchurch are made using rail). A more conservative estimate of freight contestability might take the approach that growth in traditional rail markets is the most likely outcome. Certainly, the recent increase in demand for coal is to the benefit of rail. If Toll were able to grow their market share in the dairy products and coal sectors by 20%, where theoretically no truck involvement is required, and by 5% in the other sectors, not including the freight-forwarding sector, then an overall rail modal share of approximately 16% (3% modal share change) would result on a tonnage basis. If Toll were also able to take 5% of the general freight market from trucks, then using this approach, an overall modal share of approximately 19% (6% modal share change) would result.

Another way to estimate rail growth might be to examine the capacity of all current operations. According to the Toll Master Train / Ferry Plan[10] there are 687 train services that run in the North Island per week. Of these, 603 are freight trains (275 bulk). In the South Island there are 346 train services per week, of which 300 are freight services (98 bulk). It is estimated that the current train fleet is working at approximately 54% of time-tabled capacity[11], yet it is generally accepted that general freight utilisation should be at least 65%[12].

[10] Toll Rail. Toll Master Train / Ferry Plan as of 0001 hours Sunday 12 Feb 2006.
[11] Toll Rail. Toll Master Train / Ferry Plan as of 0001 hours Sunday 12 Feb 2006.
[12] Personal communication Peter Morris, Strategy and Planning, Toll Rail.

If rail were able to increase its freight transport by 11% of current timetabled capacity and was able to keep up with the expected overall growth in freight volumes, then this would lead to a rail modal share of approximately 16% (3% higher than present) on a tonnage basis.

Based on the three rail growth scenarios, it is estimated that a 3-7% share of the current road freight task is currently contestable by rail. It would be unlikely that rail could transport more than 20% of the current freight task without revolutionary changes to the way freight is transported in New Zealand. However, some recent rail initiatives such as the Fonterra dry storage facility in Hamilton, indicates that rail can have a significant affect on regional freight transport in specific cases.

Scenario	Conditions	Outcome
1	Estimate of freight contestability based on 'economically and practically viable' rail links	Possible 20.6% modal share
2	Estimate of freight contestability based on growth in major commodity and freight forwarding transport	Growth in commodity transport only: 16% modal share Including possible general freight growth: 19% modal share
3	Growth in the payload of current rail operations (increasing freight carried as % of maximum capacity by 11%)	Possible 16% modal share
	Overall estimate for possible modal share	**Approximately 16-20%**

Table 3. Likely modal shares for rail based on three different approaches to estimating rail freight growth.

If current rates of growth were to continue, by 2020 rail would transport 14.8% and road would transport 85.2% of the freight task on a tonnage basis. In absolute terms this equates to a tonnage increase (from 2005) of 18.6 million tonnes for rail and 95.7 million tonnes for road. This demonstrates that if current trends persist, the bulk of the future freight growth will still need to be accommodated by trucks.

Although outside the scope of this study, it should also be considered that most freight that currently travels on rail is contestable by road. Coal transport (for example West Coast to Lyttelton) is likely to be an exception to this as trucks are unlikely to be able to transport such large volumes of a relatively heavy, low cost commodity over the Southern Alps as effectively as rail.

Some other countries have very good road and rail freight movement statistics, which provides a solid basis for research projects. Better freight transport information would reduce the assumptions and estimates that currently have to be made and increase the effectiveness of future freight transport studies. Also, more detailed analyses at a regional level are required as factors such as accessibility to rail infrastructure, freight type and volume, and existing road congestion will differ between regions, and when these factors are combined, some regions will be more suited to rail investment than others. Furthermore, geographic, topographic and infrastructure constraints need to be considered. On some New Zealand railway lines, tunnels cannot accommodate modern containers, restricting the types of freight that can be transported on those lines.

The potential for other modes

The potential for increased use of other freight transport modes is outside the scope of this study but requires significant further investigation. It could be regarded that New Zealand's coastal shipping and barging is under-utilised and with infrastructure investment this mode could significantly assist in transporting our growing freight task in the future. Examples that have been investigated include aggregate, logs and seafood from relatively inaccessible locations such as North Island's East Cape and Coromandel Peninsula to processing facilities.

Pipelines are already used in New Zealand to transport Oil, fuel, natural gas and ironsand. This method may also provide an alternative method of transporting other materials such as milk or milk powder in the future.

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