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New Zealand Agricultural and Resource Economics Society (Inc.)

The Impact of Demographic and Structural Change on Transport Use

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Summary

The 2002 *New Zealand Transport Strategy* states that in the long run, economic development and transport activity need not be directly related. This implies that a degree of ‘decoupling’ is required – that economic development needs to occur without similar growth in transport. Before evaluating the possible impacts of policies that may be introduced to achieve decoupling, it is vital to consider what might happen to the relationship between economic development and transport over the next 50 or 100 years. Two key factors that are likely to impact upon this relationship in the future are demographic change and structural change. This paper suggests that in the absence of any policy change, some decoupling of economic development and transport may take place as a result of these two factors. However, income growth and transport demand from the rapidly growing tourism sector may push total transport growth use up.

Key words

Transport, economic development, decoupling, demographics, energy

THE IMPACT OF DEMOGRAPHIC AND STRUCTURAL CHANGE ON TRANSPORT USE

By John Ballingall and Doug Steel, NZIER

1. INTRODUCTION

In recent years, there has been growing interest both in New Zealand and overseas in the links between transport and the economy. In most developed countries, there has traditionally been a strong positive relationship between economic growth and transport growth. However, transport activity leads to negative side-effects or externalities such as air pollution and congestion.

Given that economic growth increases the welfare of a country, and these negative externalities reduce welfare, policymakers are considering how a country can experience economic growth without facing the negative side effects of transport growth. Breaking or weakening the link between economic growth and transport growth is known as 'decoupling'.

The issue of decoupling has recently been raised by the New Zealand government. The 2002 *New Zealand Transport Strategy* states that in the long run, economic development and transport activity need not be directly related. This implies that a degree of decoupling is required – that economic development needs to occur without similar growth in transport. The New Zealand Institute of Economic Research has been investigating decoupling in New Zealand, with funding from the Ministry of Transport.¹ Most numerical measures indicate that decoupling has not occurred to any great degree in New Zealand to date.

Before evaluating the possible impacts of policies that may be introduced to achieve decoupling, it is vital to consider what might happen to the relationship between economic development and transport over the next 50 or 100 years. Three key factors that are likely to impact upon this relationship in the future are:

1. Demographic change – how will the aging population affect the demand for transport by households?
2. Structural change – New Zealand's services sector is expected to increase in importance relative to agriculture and manufacturing. Given that service providers use (on average) less transport than agricultural or manufacturing

¹ Although NZIER has prepared a number of reports for the Ministry on issues surrounding decoupling in New Zealand, this topic is still relatively new in the New Zealand context. It is hoped that by raising awareness of some key issues, our work may prompt other researchers to consider decoupling as a research topic. The views presented in this paper are those of the authors only, and should in no way be interpreted as the Ministry's opinions.

firms, what will this mean for transport demand from the productive sector of the economy?

3. Tourism growth – Tourism is a rapidly growing sector that is forecast to grow at around 8% per year for the foreseeable future. To what degree will this result in increased pressure being placed on the transport network?

Our hypothesis was that the net effect of these three factors may be that even in the absence of any policy change, a decoupling of economic development and transport may take place.

This paper looks at each of these factors in turn and projects transport use out to 2051 (for transport used in the freight/production side of the economy) and 2101 (for transport used by households). By comparing this projected transport use with projections of long run economic growth, it is possible to examine our hypothesis. The initial results suggest that demographic change and structural change alone could have a dampening impact on transport use. However the effects of income growth and continued tourism growth will push transport use up. The overall result is that decoupling is unlikely to occur on an economywide basis.

While these results are illustrative only, and are based on a number of assumptions that could be strongly debated, the methodology and thought processes generated by this research should prove to be useful to those with an interest in sustainable transport. It is hoped that our paper will spark debate on decoupling amongst the transport research community in New Zealand and Australia, as to date there has been little research conducted on the topic in the Australasian region. It is important to note that we do not purport to have all of the answers to the questions that arise from examining decoupling more closely. However, we believe that this paper will serve a useful purpose in introducing the topic area and raising some of the problems that are associated with defining and measuring decoupling.

This paper is organised as follows. Section 2 provides the policy background for this research. Section 3 provides an overview of some of the key issues surrounding decoupling. Section 4 specifies the questions that this research aims to consider. Section 5 describes the broad methodologies used in the research, and presents the key results. Section 6 draws some broad conclusions, highlights some limitations to the analysis and suggests some areas of future research. Three appendices explain the various components of our methodology in greater detail.

2. POLICY BACKGROUND

The New Zealand government released its *New Zealand Transport Strategy* (NZTS) in December 2002. The NZTS outlines the government's vision for the development of the New Zealand transport system to 2010. While the NZTS contains a broad range of

transport-related objectives related to economic, environmental and social issues, from an economic research point of view one comment in particular warrants attention:

In the long run economic development and transport growth need not be directly related...[and the government's] approach will minimise the extent of transport growth necessary to achieve economic development goals, and in particular minimise transport-related energy consumption (NZTS, 2002, p. 10).

This implies that some degree of 'decoupling' needs to take place in the New Zealand economy – that the link between transport and economic development needs to be weakened or broken. Because the NZTS is a high level strategic document, it does not discuss how this 'decoupling' might be measured, how it might occur and what impact policies to achieve decoupling might have on the economy.

In 2002, the New Zealand Ministry of Transport (MOT) engaged NZIER to consider some broad issues surrounding the concept of decoupling. Since then, NZIER has completed a number of pieces of research (NZIER, 2002; NZIER, 2003a, b) to help MOT to further understand the topic. This research is ongoing. Before discussing the results of our most recent research (NZIER, 2003b), it is useful to summarise some of the findings of our earlier work.

3. A PRIMER ON DECOUPLING²

3.1 ECONOMIC DEVELOPMENT, TRANSPORT GROWTH AND EXTERNALITIES

In most developed countries, there has traditionally been a strong relationship between economic growth and transport activity growth. The provision of physical infrastructure (roads, railways, ports, airports, etc) is generally agreed to be of vital importance to economic development (SACTRA, 1999). However, it is also generally accepted that as transport increases, so too do its undesirable side effects – air pollution, noise pollution, CO² emissions, contaminated water run-off, congestion and stress. It should be noted that there are also positive externalities arising from some forms of transport growth, such as improved social interaction for isolated areas.

In recent years, there has been considerable interest in the links between transport and the economy, prompted mainly by policymakers in the EU. If transport growth and economic growth are strongly related, but transport growth leads to significant negative side-effects, the question that many researchers and policymakers are trying to address is how can a country experience economic growth without facing the negative side-effects of transport growth?

² Much of this section is taken from Ballingall, Steel and Briggs, 2003. A comprehensive literature review is contained in NZIER (2002). The references section of this report contains details of many of the key reports on decoupling that have been published overseas.

The seemingly simple answer to this question is to have economic activity growing faster than transport activity, thus breaking/weakening the link between economic growth and transport growth and its side effects. Breaking or weakening this link has come to be known as ‘decoupling’ economic growth and transport growth.

3.2 ENVIRONMENTAL AND ECONOMIC ARGUMENTS FOR DECOUPLING

At a general level there are two reasons why a government may want to decouple transport and economic growth:

1. It may want to reduce the level or growth in negative externalities (pollution, congestion, etc) associated with transport growth without dampening economic growth. This is the environmental argument for decoupling.
2. It is striving for productivity gains across the economy. Economic growth (or development) can be achieved by reducing the amount of transport required per unit of output generated by the economy. If fewer inputs are used to produce a given level of output, a productivity gain is generated. This increases GDP. Therefore even in the hypothetical case where there were no externalities from transport activity, a government may still wish to decouple. This is the efficiency argument for decoupling.

The relative importance of the productivity or environmental reasons for stating decoupling as a goal is a political issue, and is likely to depend on the set of preferences displayed by society. However, the two motivations overlap – by achieving decoupling, productivity gains and hence economic development will take place, and the growth in negative externalities from transport will ease. The NZTS’s statements noted in section 2 above indicate that decoupling has been adopted as a policy goal for both environmental and efficiency reasons.

3.3 SOME DEFINITIONAL ISSUES

As a broad concept, decoupling is not too difficult to grasp. However, look a little deeper and it becomes clear that definitional issues are vital when it comes to working out exactly what a government is trying to achieve. One key point relates to stating clearly what ‘transport’ and ‘economic development’ are when we refer to decoupling economic development and transport growth.

What is ‘transport’?

There is a large distinction between the use of transport in the production of goods and services, and the use of transport by households as a consumption good. The distinction between transport as an input to production and transport as a consumption good is important for decoupling policies, as is the interaction between the two forms of transport.

Production transport involves transport activity related to the production of goods and services and essential household sector activities. Broadly, production transport includes

the transport activity used to get raw materials to the production location, the transport required to transform raw materials into final goods, plus the transport activity used to get these goods to their final destination. If a monetary value can be placed on the output of an economic activity, then any transport required in the activity could be defined as production transport. In addition, certain elements of households' daily operations could be classified as productive transport. This covers activities such as the trip to work and shopping for essentials such as food and clothing. Without these activities the productive capacity of the economy would be lower.

Consumption transport can be defined as covering the use of transport by individuals, households and tourists for non-essential purposes (including leisure). Consumption transport provides households and tourists with utility (or satisfaction). Much of this transport – trips in self-driven cars – is not a product or service purchased at market prices or captured in the national accounts.

As an input (and hence a cost) to production, firms have an incentive to minimise their use of transport. As a consumption good, households like to consume more of it as their incomes increase. This creates an immediate dichotomy. If firms reduce their use of transport via improved productivity, GDP (or national income) will increase. On its own, this represents decoupling in the production sector. However, households treat transport as a 'normal good' – their consumption of transport for leisure purposes increases as incomes rise. Therefore reducing transport use in the production sector will generally lead to an increase in consumption transport. The net effect on overall transport activity is ambiguous.

This has implications for the development of decoupling policies. A policy that resulted in firms reducing their use of transport could in fact increase households' consumption of transport as a leisure good. Obviously, this may not be an effective policy.

Policies that affect consumption transport will also have an impact on production transport. For example, if policies are introduced that restrict leisure transport, then the producers of goods and services that are consumed by households and tourists on trips associated with leisure travel may suffer as demand falls. On the other hand, such policies may cause consumers to substitute other goods and services for transport activity – for example, they might spend more time in the garden instead of going on a day trip to the beach and might therefore spend more on gardening products.

Economic development vs. economic growth

The NZTS statement aims for a decoupling of transport and economic *development*. The distinction between economic development and economic growth is vitally important when it comes to considering policies that might achieve decoupling. Economic development is generally thought of as encompassing more than just rising per capita incomes. It also usually covers environmental, social and cultural objectives. This complicates the evaluation of policy frameworks, as it is often difficult to develop policies that will improve economic, social, environmental and cultural outcomes in one fell swoop.

Stead (2001) noted that until a universally accepted set of definitions and indicators are developed, monitoring progress on changing decoupling will be difficult. We agree with Stead's sentiment. While there is generally a broad agreement on the concept of decoupling (i.e. the goal is to weaken the link between transport activity and economic activity), a consistent method of measuring decoupling has yet to be developed.

3.4 INDICATORS OF DECOUPLING IN NEW ZEALAND

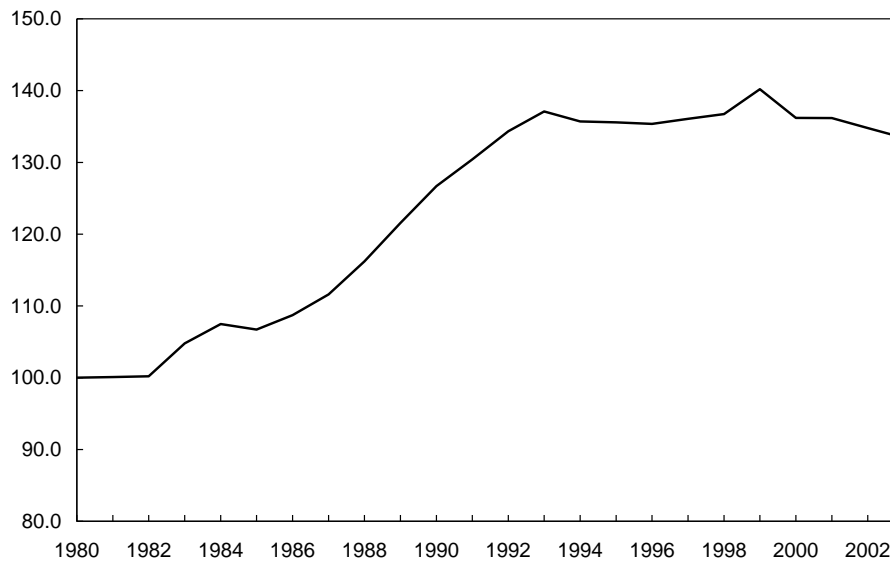
As part of our initial examination of possible trends in the relationship between economic development and transport activity in New Zealand, we analysed various ratios of 'transport' and 'economic development'.³ This proved to be a frustrating task. Firstly, there is no measure of economic development available in New Zealand. Thus we had to use economic growth as a proxy. Various measures of transport activity were available, but all of them had weaknesses primarily related to a lack of comprehensive coverage. Perhaps the best measure of overall transport activity in New Zealand is vehicle kilometres travelled (VKT). This measure sums the distances travelled by private cars, freight vehicles, trains etc in any year. The main problem with this measure is that it doesn't include any indication of the amount of goods being transported.

Figure 1 below shows an index of the ratio of VKT to real GDP since 1980. If the ratio decreases, this indicates that transport has grown at a slower rate than economic activity, indicating some degree of decoupling. There are many reasons why the ratios may have changed including relative price changes, demographics, income changes, economic structural changes, modal switches, productivity and efficiency gains, changes in capacity utilisation, and deregulation.

The chart suggests that since 1993, the relationship between transport growth and economic growth has remained relatively steady, and perhaps that from the late 1990s onwards, economic growth has actually outpaced transport growth. As such, this indicator suggests that there may be some early signs of decoupling occurring in New Zealand. However, given the data issues encountered, it is difficult to make any firm conclusions.

³ For a summary, see NZIER (2003b, p. 6) and Ballingall *et al* (2003).

Figure 1: Index of Ratio of total VKT to Real GDP, 1980 = 100



Source: Ministry for the Environment (2004), Transfund (2004), Statistics New Zealand (2004), Briggs (2003).

These definitional and measurement issues notwithstanding, in this paper we now go on to determine a ‘business as usual’ scenario for analysing the relationship between economic activity and transport growth.

4. PROBLEM SPECIFICATION

NZIER’s work on decoupling to date has highlighted a number of ‘holes’ in the existing body of international research. To summarise, these gaps are as follows:

- A commonly-accepted and precise definition of decoupling needs to be developed.
- Once this definition is specified, quantitative indicators of decoupling trends need to be developed. These need to encompass industry and modal differences in the relationship between economic activity and transport use.
- These indicators need to be calculated over as long a time period as possible so that long run trends can be identified.
- Using qualitative and quantitative research techniques, these trends need to be examined under a scenario where no policy intervention occurs. This analysis will demonstrate what will happen to the relationship between transport growth and economic growth in New Zealand over coming decades due to demographic change and structural shifts, if long run trends continue.
- If this ‘business as usual’ analysis suggests a need for policy intervention to achieve decoupling, policy options need to be developed. These options should then be assessed to gauge their impact on economic performance (GDP, sectoral

output, employment), social factors (access and mobility) and environmental indicators (emissions, congestion, pollution).

In this report we focus on the latter two bullet points in the above list. The overall aim of the research is to consider how the relationship between transport and economic activity might change in the future.

Three key factors that are likely to impact upon this relationship in the future are:

1. Demographic change – how will the aging population affect the demand for transport by households?
2. Structural change – New Zealand’s services sector is expected to increase in importance relative to agriculture and manufacturing. Given that service providers use (on average) less transport than agricultural or manufacturing firms, what will this mean for transport demand from the productive sector of the economy?
3. Tourism growth – Tourism is a rapidly growing sector that is forecast to grow at around 8% per year for the foreseeable future. To what degree will this result in increased pressure being placed on the transport network?

It is possible that structural, technological and demographic changes may lead to a decoupling of transport activity and economic growth without the need for any policy intervention. In this section we develop an indicative business as usual (BAU) scenario for transport use over the next 50 or 100 years.

This BAU scenario comprises projections for the transport activity associated with industry (including business travellers), households and overseas travellers in New Zealand. Developing this BAU scenario is a vital part of our research agenda, as it may suggest that decoupling may not be a problem in 50 or 100 years time in New Zealand – that economic development and transport growth may have already decoupled without any decoupling policy intervention.

To analyse this BAU scenario, we project transport demand and GDP out to 2051 (on the production side of the economy) and 2101 (on the household side) and then examine the ratio of the two variables to determine if decoupling is likely to occur. We also consider how significant the transport demand from the tourism sector might be.

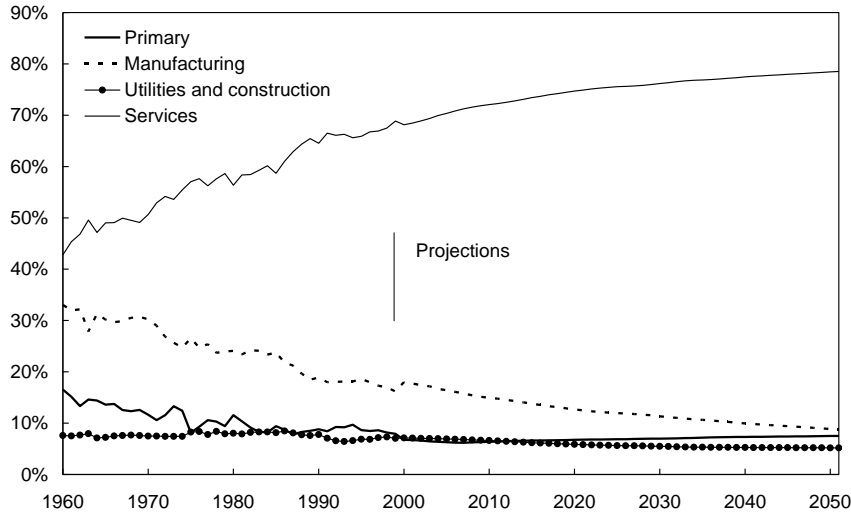
5. METHODOLOGY AND RESULTS

5.1 PROJECTIONS OF GDP

Using nominal GDP by industry data (Briggs, 2003), we determined 21 industries’ GDP shares between 1960 and 1999. We projected these shares forward to 2051 using a linear trend. In some instances the linear trend estimate made an industry’s share of GDP in the

future fall below zero. As this is obviously not possible, we limit any sector “shrinkage” to a minimum of half the 1999 industry share. This results in the sum of the shares being greater than 100%. The difference is pro-rated across the sectors.⁴ The GDP shares are shown in Figure 2. The services sector moves from currently accounting for around 70% of New Zealand’s GDP up to around 80% by 2051. Manufacturing, in contrast, shrinks as a proportion of GDP, from around 16% to 9%. There are slight reductions in the shares of primary and utilities/construction sectors.

Figure 2: Projected shares of real GDP by broad sector



Source: Briggs (2003), NZIER (2003b)

Using these GDP shares and the economywide real GDP forecasts from NZIER’s *Quarterly Predictions* industry projections, we calculate the level of real GDP by industry to 2051.

5.2 PROJECTIONS OF TRANSPORT

In order to examine the effects of demographic change, structural change and tourism growth on transport demand, we analysed three separate parts of the New Zealand economy in relation to their transport activity:

1. The production sector (movement of goods and business travel).
2. The household sector (movement of people).
3. The tourism sector (movement of overseas travellers).

The process of projecting transport out to 2051 for each of these sectors was rather cumbersome. Due to data difficulties, a host of assumptions and proxies were employed. In particular, we had to use fuel use as a proxy for transport activity at a sectoral level.

⁴ We cannot use real GDP shares for our projections as there is a problem with chain-weighting. The sum of real GDP industry shares does not sum to 100%. Thus we have to use nominal GDP shares. This underestimates the volume growth of the communications sector as its deflator is negative due to computer prices.

This is far from ideal (see Appendix A). In the sections that follow, we outline broadly the methodology used in our research.

Our projections of transport activity by sector are necessarily subject to a high degree of error. Refining our transport projections remains a key part of future research.

5.3 IMPACT OF STRUCTURAL CHANGE ON TRANSPORT

Recent government policy is aimed at reducing our reliance on the commodity sectors, and transforming the New Zealand economy into a services and light manufacturing based ‘knowledge economy’. This kind of economic transformation has been the holy grail of many New Zealand governments. Such a transformation may over time reduce the energy/transport intensity of the New Zealand economy through the relative expansion of less energy/transport intensive sectors.

This raises a very important question for this study of the drivers of transport activity and likely future trends in decoupling: if the services sector uses less fuel (and hence less transport) than the primary and manufacturing sectors, and it is poised to increase in importance over the next, say, 50 years, then will this structural change lead to a weakening of the link between production-related transport and economic activity?

The aim of the analysis is to assess what the impact of structural change might be on production-related transport. In this base case scenario, we do not consider at this stage the effects of any other technological or policy changes. We assume that the only change in the New Zealand economy over the next 50 years is from changes in the composition of New Zealand’s GDP. Once this scenario is developed, adjustments can be made to incorporate changes in transport efficiency, different elasticity assumptions, etc.

The key steps in our analysis were as follows:⁵

1. Using our historical GDP by industry data and data on transport activity (proxied by fuel use) by industry, we calculated the ratio of transport to GDP in each of 21 industries for 1999 (the last year for which we have data).
2. We assume that each industry’s use of transport per dollar of industry GDP stays constant at 1999 levels out to 2051.⁶
3. For each year out to 2051, we used the following formula to calculate transport use by industry i :

$$\text{Transport use}_i = \text{GDP}_i * \left[\frac{\text{Transport use}_i}{\text{GDP}_i} \right]$$

⁵ A detailed methodology is presented in Appendix B.

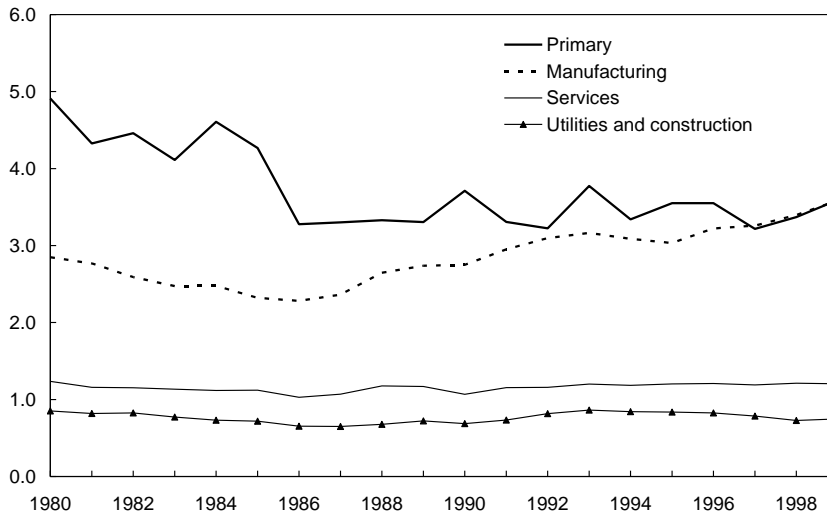
⁶ At this stage, no improvements in transport efficiency were built into this BAU scenario. This will form part of our future work.

4. By summing across industries, we estimated for each year out to 2051 the transport associated with the production sector in New Zealand.

Before looking at the results of the projections incorporating structural change, let us first examine the historical fuel use by sector. Figure 3 highlights the dominance of agriculture and manufacturing in transport-related fuel use in New Zealand. These sectors are heavily transport-intensive, and in the case of manufacturing, appear to be becoming more reliant on transport over time.

On the other hand, the services sector uses around 2/3 less transport-related fuel per dollar of GDP than the primary and manufacturing sectors. Fuel use in the communications and business services sectors in particular is low and decreasing over time, relative to GDP.

Figure 3: Ratios of fuel use to GDP by broad sector

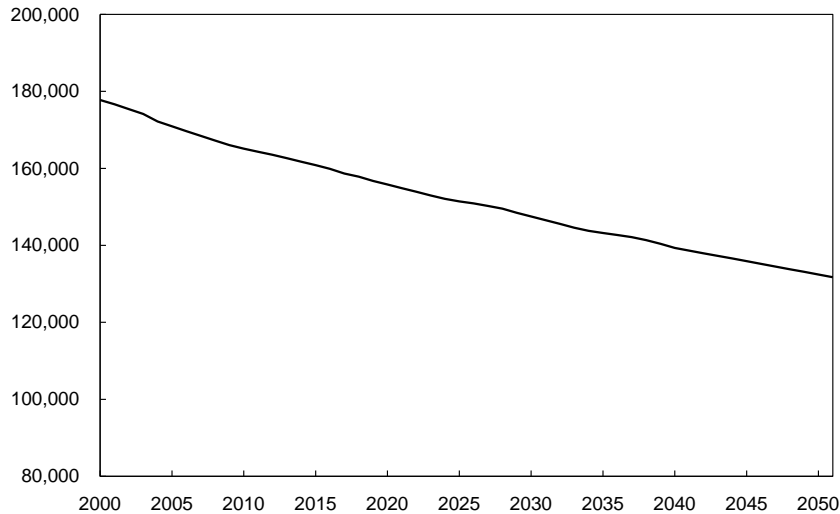


The figure indicates why structural change that causes the services sectors to account for a greater proportion of New Zealand's GDP at the expense of primary production and manufacturing is likely to have a significant impact of transport use in the future.

The results of our projections of transport-related fuel use by industry are shown below. Under the assumptions employed in the analysis – and there are many – structural change on its own will have a negative impact on fuel use over the next 50 years.

Figure 4: Projected transport activity in the production sector: structural change effects only

Petajoules of fuel use



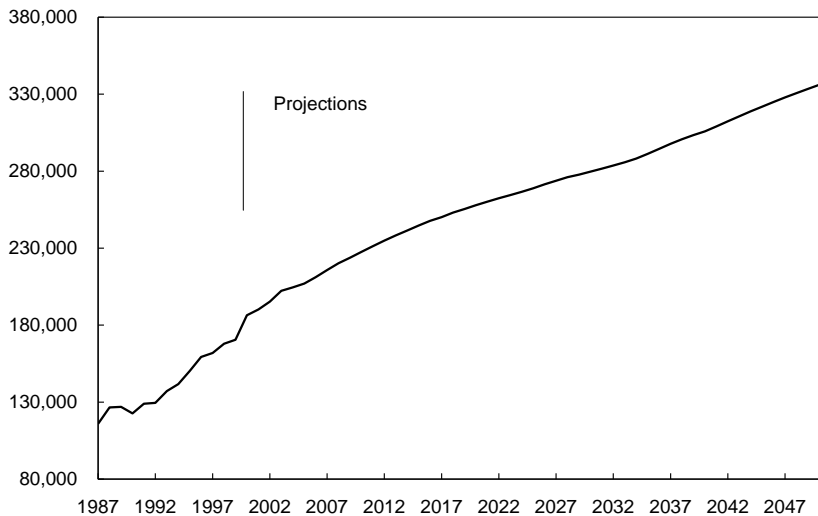
Source: NZIER (2003b)

However, it must be re-iterated that the structural change analysis does not take into account any increases in activity (GDP) or improvements in transport/fuel efficiency. This analysis solely looks at what changes in the *composition* of GDP might mean for transport use.

One way of incorporating increases in activity into the analysis is to allow each industry's use of fuel to increase at the same rate as that sector's growth. This implies an elasticity of demand for fuel use with respect to industry GDP of +1. When the effects of increased activity are added to the structural change results (see Figure 5), overall fuel use in the production side of the economy increases by an average of 1.3% per year between 2000 and 2051. In the outer years, as services starts to play a more significant role in the New Zealand economy, fuel use growth drops to just 0.8% per year.

Figure 5: Projected transport activity in the production sector: structural change and GDP increase effects combined

Petajoules of fuel use



Source: NZIER (2003b)

5.4 IMPACT OF DEMOGRAPHIC CHANGE ON TRANSPORT

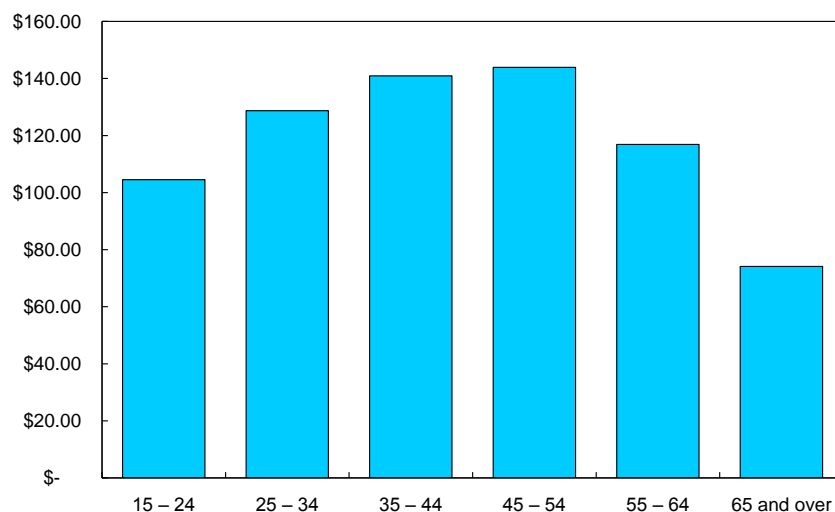
Demographic change is another factor that needs to be taken into account when considering decoupling transport and economic activity in New Zealand. The focus of this section is on transport associated with households, and specifically, self-supplied (private car) travel.

New Zealand's population is aging. As the population gets older, the proportion of the population in the labour force will decline. These changes will have an influence on the relationship between transport and economic activity in New Zealand. Statistics New Zealand's Household Economic Survey (HES) provides data on average weekly expenditure on transport by age cohort. The latest data is for the year ended June 2001, and shows that transportation expenditure drops away over the age of 55 years old.

The type, as well as the level, of transportation expenditure varies by age cohort as well. The elderly age brackets tend to spend more on overseas travel, and less on road vehicles. Given that over the next century, there will be a significant shift of people into the post-55 years old age cohorts, this would suggest that overall transport expenditure is likely to drop as the population ages. It also suggests that there may be shifts in the types of transport demanded.

The analysis in this section on demographic change aims to answer the following question: what will be the impact on household transport expenditure of demographic shifts in the absence of any policy intervention?

Figure 6: Average weekly expenditure on transport by age cohort
Dollars per week, 2001



Source: Statistics New Zealand

The aim of this analysis is to assess what the impact of demographic change might be on households' use of self-supplied (private car) transport. In this base case scenario, we do not consider at this stage the effects of any changes in tastes and preferences or policy changes. We assume that the only change in households' self-supplied transport behaviour is due to an aging population. Once this scenario is developed, adjustments can be made to incorporate changes in tastes, modal shifts, different elasticity assumptions, etc.

The key steps in our analysis were as follows:⁷

1. Projecting New Zealand's population by age cohort out to 2101.
2. Estimating average current use of self-supplied transport for the individuals in each age cohort.
3. Holding this usage in each cohort constant, for each year multiply the number of projected individuals in each cohort by the transport usage of that individual.
4. By summing across cohorts, we obtain households' self-supplied transport demand out to 2101.

Once again we encountered data problems when trying to determine transport use by age cohort. We had to again resort to using purchases of fuel related to road vehicles as a proxy for private car transport by households. Using HES data for 2001, we estimated expenditure by age cohort. This expenditure data clearly shows that those between 35 and 54 years old spend most heavily on fuel for road vehicles. However, the most salient

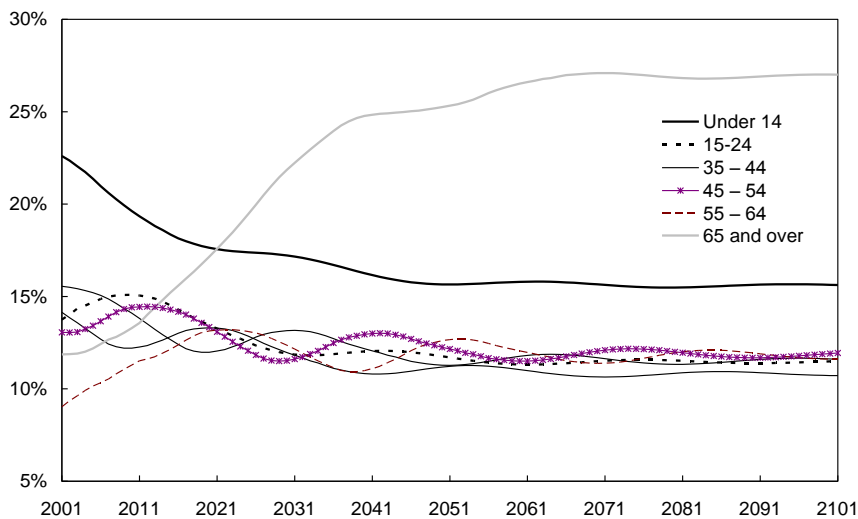
⁷ A detailed methodology can be found in Appendix C

point for this analysis is that the over 65 age group spends less than half as much (on average) as the 35-54 years old cohort. As the high-spending cohorts age and move into the over 65 years old group, patterns of transport expenditure are likely to change dramatically.

Our population projections were taken from Statistics New Zealand. Statistics New Zealand produces a number of projections of the national population under various assumptions regarding fertility rates, mortality rates and migrant flows. These projections are available by age cohort, so we were able to project how many people will be in each age cohort in each year of our projection period. We used Statistics New Zealand's projections that were based on medium death rate and medium birth rate assumptions, incorporating annual net migration inflows of 5,000 per year. We adjusted the projections to account for recent net migration flows that have reached well over 40,000 in the past year. The shares of total population of each age cohort are shown in Figure 16 and the chart demonstrates the aging population phenomenon clearly. The proportion of the population aged 65 and over increases from its current level of 12% up 27% by 2101.

Figure 7: Age cohort shares of total population

Proportion of total



Source: Statistics New Zealand, NZIER

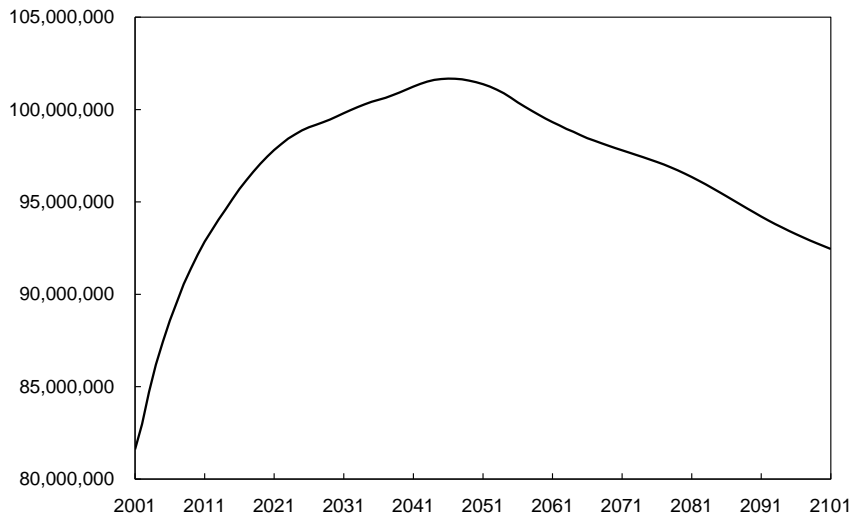
By multiplying the number of people in each cohort by that cohort's 2001 road fuel use expenditure, and summing across cohorts, we get total road fuel use expenditure projections to 2101, due solely to demographic shifts.

The impacts of demographic change on the use of household transport use alone are startling. As shown in Figure 8, total household expenditure on fuel for road vehicles increases up to around 2050, albeit at a slowing rate of growth. This increase in expenditure reflects the movement of today's population in the 15-34 years old age bracket into the higher-spending 35-54 years old cohorts. However, as the demographic

shift into the over 65 years old cohort gathers pace, expenditure on fuel for road vehicles starts to drop. It continues to fall at around 0.2% per year between 2050 and 2101.

Figure 8: Impacts of demographic change only on households' demand for transport

Weekly expenditure on fuel for road vehicles, \$2001



Source: NZIER (2003b)

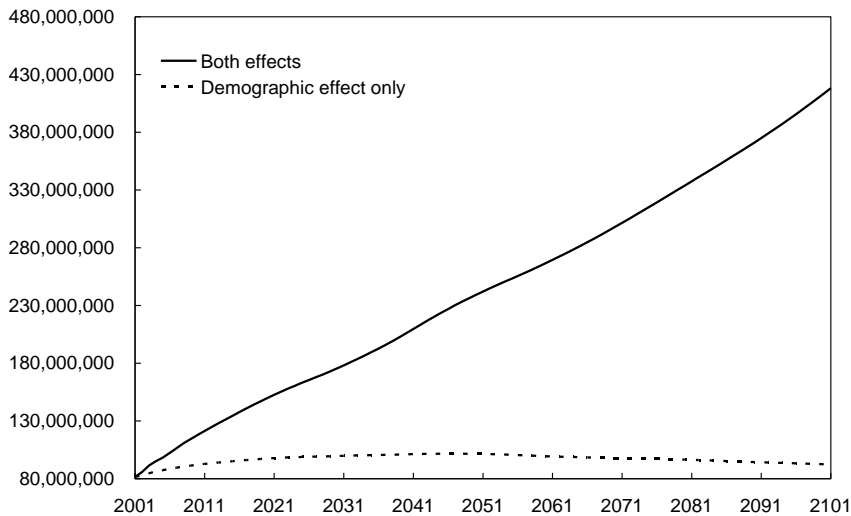
It is important to note that consumers' tastes and preferences related to transport will undoubtedly change over the projection period. Technological change and improvements in fuel efficiency will also impact on transport use. These changes are not included in this analysis as yet.

One variable that does need to be taken into account, however, is income growth. As households' incomes rise, their expenditure on road transport is likely to increase. We can incorporate this income growth into this analysis – crudely – by assuming that households' expenditure on fuel for road vehicles increases at the same rate as real GDP growth over the projection period. Clearly this is unlikely to occur – the elasticity of petrol consumption to income in the long run is likely to be below unity. Our elasticity assumptions can be altered in future work.

Under our assumption of an elasticity of +1, the household income effect on fuel use for road vehicles swamps the demographic change impacts. The impacts of both effects are shown in Figure 9.

Figure 9: Impacts of demographic change and income growth on households' demand for transport

Weekly expenditure on fuel for road vehicles, \$2001



Source: NZIER (2003b)

5.5 THE IMPACT OF TOURISM GROWTH ON TRANSPORT

The tourism sector is a major contributor to New Zealand's economy, ranking alongside dairy as our highest value export. Transport associated with the tourism sector needs to be looked at separately from production or household transport, as the factors that affect the transport demand by visitors to New Zealand are likely to be different to those that affect domestic households. For example, there is a relatively strong relationship between the number of tourists visiting New Zealand from an overseas country and that country's economic growth and cross-rate with the New Zealand dollar. In contrast, the demand for transport from New Zealand households is to a large extent dependent on the level of domestic activity.

The focus of this section is on tourists' self-supplied transport. That is, the transport associated with tourists in rental cars, camper vans, etc.

The aim of this section is to assess what the impact of continued strong growth in international visitors coming to New Zealand might be on tourists' use of self-supplied (private car) transport. In this base case scenario, no adjustments are made for technological change or changes in visitors' preferences for travelling around New Zealand.

Presently, we are not aware of any data that indicates what proportion of transport is directly attributable to the tourism sector. However, we were able to estimate this (crudely) using the following steps:

1. We had data on total fuel deliveries from Statistics New Zealand. We looked only at the petrol and diesel components.

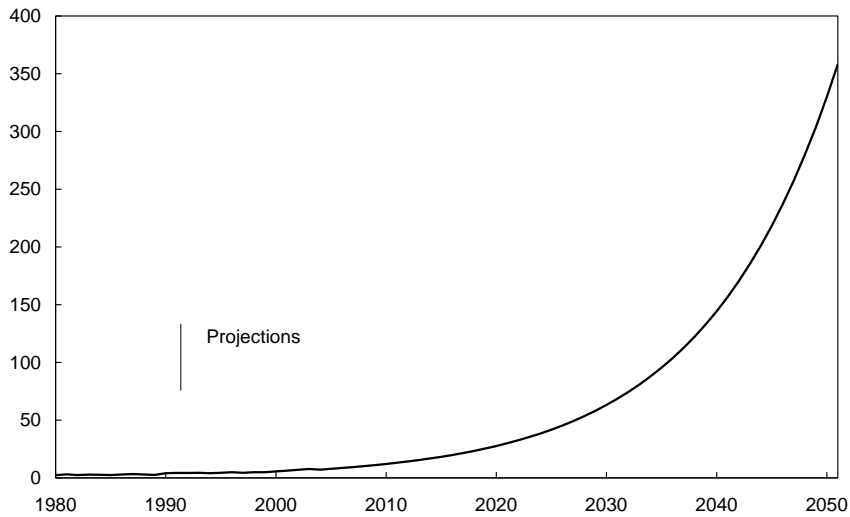
2. Subtracting the production sector's use of petrol and diesel, the remainder is fuel for road vehicles used by households and tourists.
3. We needed to split this remainder between households and international tourism. For this we use Statistics New Zealand's HES and Tourism Satellite Accounts and looked at households and tourists' expenditure on fuel. This gives us the relative proportions of the non-industry fuel use (i.e. self-supplied transport) for the household and tourism sectors.
4. Comparing the annual fuel expenditure of households (\$2.03 billion) and international tourists (\$252 million), this suggests that 89% of non-industry fuel use is apportioned to households, and 11% to tourists.
5. We assume the household/tourism split stays constant over time.

We then used forecasts of growth in tourism expenditure in New Zealand to project forward fuel use for self-supplied transport in the tourism sector. The source for these forecasts for 2003-2008 is our September 2003 *Quarterly Predictions* publication. After 2008, we assume that tourism growth will continue at its historical average growth rate of 8.6%.

Note that this assumes that the elasticity of transport to tourists' expenditure is +1. This is unlikely to be true, with the Tourism Satellite Account suggesting that the proportion of tourists' total expenditure spent on fuel is tending to trend downwards. However, the data upon which the chart is based (our derivation of fuel expenditure by tourists) is only our best guess – we have no official data for self-supplied transport associated with the tourism sector. With this in mind, adjusting our analysis could add another degree of error.

The effects of compounding growth in tourism expenditure and a constant elasticity of demand of +1 result in exponential growth of tourists' fuel use, as shown in Figure 21. While this base case most likely represents an upper bound for tourists' self-supplied transport growth, and is based on two key (debatable) assumptions, it does at least indicate the increased role that transport associated with the tourism sector is likely to play in the future.

Figure 10: Impacts of tourism growth on transport fuel use
Petajoules



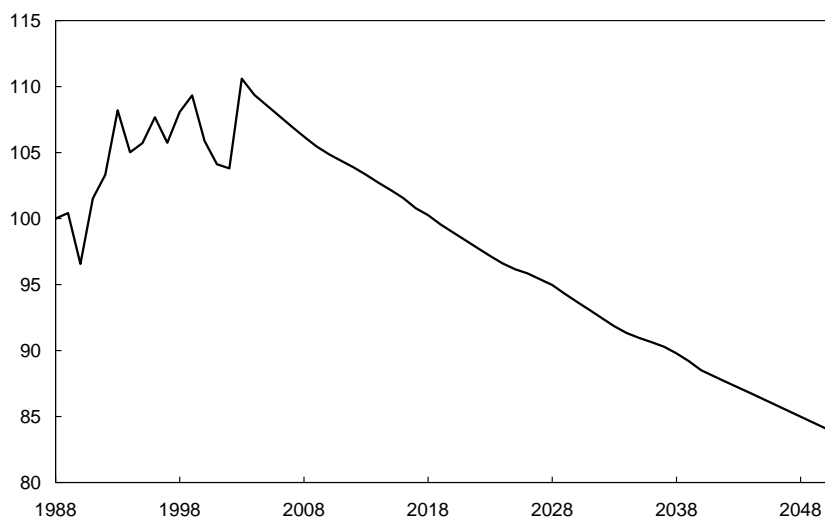
Source: NZIER (2003b)

5.6 RATIOS OF FUEL USE TO GDP BY SECTOR

Now that we have derived estimates of transport demand (proxied by fuel use) for the production, household and tourism sectors of the economy, we can compare these transport estimates to our projections of real GDP by sector in order to examine whether any decoupling is likely to occur.

Decoupling measure for the productive sector

Figure 11: Ratio of the productive sector's transport-related fuel use and real GDP
Index, 1988 = 100



Source: NZIER (2003b)

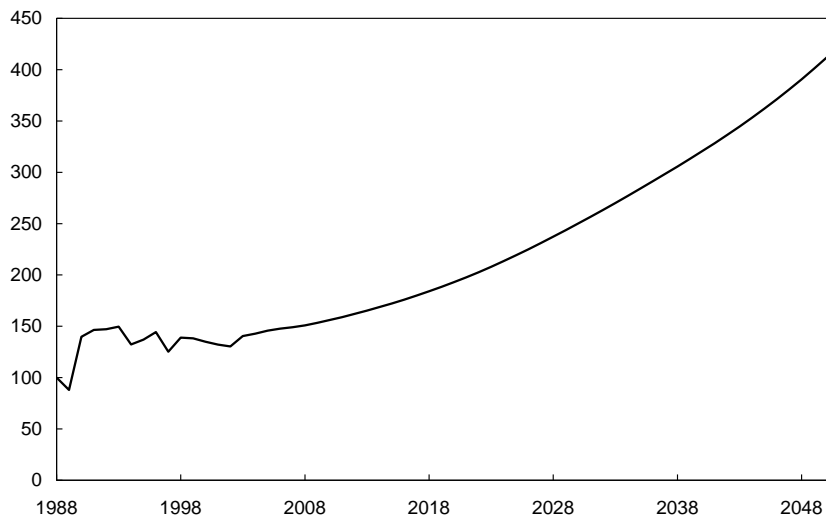
Transport-related fuel use in the production side of the economy is projected to increase by an average of 1.3% per year between 2003 and 2051. Real GDP growth is projected to average 1.7% over the same period. This indicates that for the production side of the economy, structural change will result in some degree of decoupling of transport and GDP. This decoupling is shown by the falling ratio in Figure 11.

If improvements in fuel use/transport efficiency also occur, then the rate of decoupling will increase over time. Incorporating potential gains in efficiency for each industry into this analysis was outside the scope of this project, but can be considered for future work.

Decoupling measure for the household sector

Figure 12: Ratio of the household's sector's transport-related fuel use and real GDP

Index, 1988 = 100



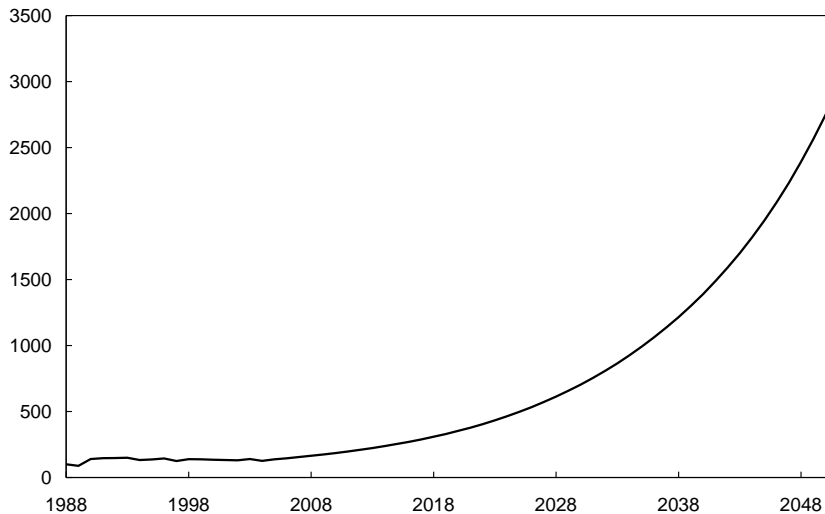
Source: NZIER (2003b)

The ratio of households' transport-related fuel use to real GDP increases over time. While demographic change alone leads to a projected fall in fuel use after 2050 (see Figure 8), over the next few decades fuel use is expected to grow more rapidly as the demographic bulge resulting from the baby boomers moves into cohorts that spend more on fuel for road vehicles. When the effects of income growth are added, fuel use rises further.

Between 2003 and 2051, annual average growth in household expenditure on fuel use is projected to grow at 4.0%, compared to real GDP growth of 1.7%. This suggests – under the various assumptions employed in our BAU analysis – that decoupling of household transport use and economic growth is unlikely to occur in the next 50 years.

Decoupling measure for the tourism sector

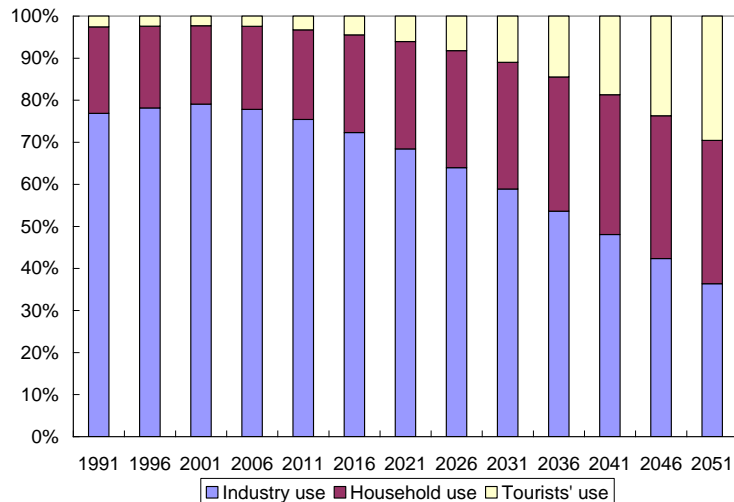
Figure 13: Ratio of the tourism sector's transport-related fuel use and real GDP Index, 1988 = 100



Source: NZIER (2003b)

The self-supplied tourism sector is projected to see rapid fuel use growth over the next 50 years. Compound annual average growth between 2003 and 2051 is projected to be 8.3% (by construction), compared to just 1.7% for real GDP. Under the admittedly crude scenario presented in this analysis, this suggests that decoupling is unlikely to occur in the tourism sector.

Figure 14: Projected composition of transport fuel use
Share of total transport-related fuel use



Source: NZIER (2003b)

The composition of transport use in New Zealand under the assumptions employed in this analysis is projected to change significantly. The further out we go, the more important the tourism sector becomes to total transport activity. The productive (labelled 'industry' in Figure 14) sector makes less of a contribution.

6. CONCLUSIONS AND FURTHER WORK

The aim of this research was to investigate the relationship between transport and economic development, and to consider what might cause a change in the relationship in the future in the absence of any policy interventions.

It must be emphasised that the results of our analysis should be regarded as illustrative only. They are intended to be a basis for discussion and to illustrate some of the key drivers of transport activity in the future. The aim was to develop a business as usual scenario and to examine the industry, household and tourism sectors separately. In order to do so, we had to make various assumptions. While these assumptions may not be correct, they allowed us to develop a model in which the parameters can be altered in future work.

The main conclusions from our research are as follows:

1. A clear and precise definition of decoupling needs to be developed by policymakers. In particular, better definitions are required of 'transport' and 'economic development' as stated in the NZTS. These should be defined with an eye to developing numerical measures of each. This will aid in quantitatively assessing historical trends in decoupling and assessing the impact of potential policy options.
2. The services sectors use 2/3 less transport-related fuel per dollar of real GDP than the manufacturing or primary sectors. As structural change in the economy occurs over the next 50 years, services will play a more important role in the New Zealand economy. By isolating the impact of structural change alone, our analysis suggests a reduction in overall transport-related fuel use in the productive side of the economy.
3. Improvements in transport efficiency are likely to reinforce this impact – meaning greater GDP will be produced per unit of transport.
4. However, the impacts of industries' income growth (or economic activity) will lift transport-related fuel use, to partly offset this drop in transport. We assume that as each sector's production activity increases, its transport use rises at the same rate. This represents an upper bound for the impact of income growth on production-related transport.

5. The impact of demographic change alone in the household sector of the economy will lead to a decrease in expenditure on fuel for road vehicles (our proxy for households' self-supplied transport) in the long run (past 2050). However, between now and 2050, the shift of the population into age cohorts that spend relatively heavily on road transport will cause expenditure to increase.
6. When income growth is included in this analysis of the household sector, the impacts of demographic change are swamped. This assumes that households' expenditure on fuel for road vehicles increases at the same rate as income. In effect, this is an upper bound for the effects of income growth.
7. Continued strong tourism growth will see the transport associated with the tourism sector (specifically self-supplied transport) grow very rapidly. By 2051, the tourism sector's share of total transport activity in New Zealand will increase from an estimated 2.1% in 2003 to around 30%. This assumes that tourists' self-supplied transport increases at the same rate as their overall expenditure – again this is an upper bound estimate.

However, these general results must be interpreted with caution. This is because:

- The modelling undertaken in this project is based on different data sets which may not be directly comparable. The need to proxy transport activity by using road fuel use needs to be considered further.
- The elasticities used in the model to represent what will happen to transport as income increases need to be adjusted. At present, we assume that transport activity increases at the same rate as industries' GDP growth, households' income growth and tourists' expenditure. These elasticities are likely to be lower in reality: transport use will increase by less than GDP/expenditure. This means that the estimates presented are upper bound scenarios.

Further work in this area is likely to involve refining the model's assumption and data sets. Once a more accurate BAU scenario has been developed, the model can be used for sensitivity analysis. That is, we can vary the key assumptions to incorporate:

- Different patterns of demographic change.
- A more rapid economic transformation
- Improvements in fuel efficiency (economywide or by industry if necessary)
- Shifts in household and tourists' transport preferences – such as modal shifts away from road freight to rail freight.

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APPENDIX A: FUEL USE AS A PROXY FOR TRANSPORT ACTIVITY

We needed to determine transport activity by economic sector. To our knowledge, time-series data does not exist on freight-related transport measures (such as tonne-kilometres) by disaggregated industry. The only suitable data set that we could find was transport-related fuel use by industry. Data compiled by Pieter Rousseau on behalf of EECA provided us with an indication of the volume of diesel, petrol, aviation oil, fuel oil and CNG/LPG used by 23 sectors in the New Zealand economy between 1980 and 1999.

We needed to adjust this data to ensure that we only considered fuel use that was related to transport activity in each sector. Three key adjustments were made:

1. Our first step was to only consider each industry's use of petrol and diesel. This is likely to account for the vast majority of transport activity in each sector.
2. We then needed to consider what proportion of the total petrol and diesel used by each industry was for transport purposes, as diesel in particular is also for power generation, heating, etc. EECA (2000, Table C8, pp. 113-115) provided some broad industry aggregate indications of fuel use by activity. We used this information to obtain transport-related petrol and diesel (henceforth 'fuel') use by sector.
3. Finally, we needed to address the fact that the transport and storage (T&S) sector accounts for around 85% of total production-related fuel use in the economy. The T&S sector provides transport services for most other industries. For example, a forestry firm will pay a freight company to move its logs from the forest to the port. This transport (or fuel use) is allocated to the T&S sector, rather than to the forestry sector. Therefore the fuel use attributed to each sector understates the true amount of fuel that is used by the sector to produce and distribute its output – a certain proportion of the T&S sector's fuel use needs to be apportioned to each sector. To do this, we used Statistics New Zealand's input-output supply and use tables to split the T&S fuel use according to which sectors purchased transport services.

Naturally, there are problems with using fuel use as a proxy for transport use. This measure does not provide us with any information about how far goods are being moved, or whether firms are now using transport more efficiently. However, it did provide us with a proxy with which to examine the impact of structural change on total transport-related fuel use in the production side of the economy.

APPENDIX B: DETAILED STRUCTURAL CHANGE METHODOLOGY

- The fuel use by industry data is from Pieter Rousseau, based on work completed for EECA. It is fuel use in petajoules by fuel type by sector, over time (1980-1999)
- A problem occurs because Rousseau's sectors are not the same as those for which we have GDP data. Some aggregation of data was needed.
- We needed to eliminate non-transport fuel use from the Rousseau data. Therefore we looked at only diesel and petrol use by sector (we omit aviation fuel, LPG, fuel oil).
- The next issue is that not all diesel and petrol use can be attributed to transport alone. Some is used in the production process, to fuel machinery, etc.
- EECA (2002) Table C8, p. 113, gives us an overview (for 1995) of the end-use of petrol and diesel by broad sector (agriculture, industrial, commercial, transport and storage, households).
- In the commercial (defined as services) and transport and storage sectors, all petrol and diesel use goes towards transport, according to the EECA table. No changes were made to these sectors.
- We needed to adjust petrol and diesel use for the agriculture and industrial (manufacturing) sectors. As the EECA end-use data is not available by disaggregated ANZSIC/NZSIC sector, we had to apply the broad EECA sectors' proportions across each of our disaggregated sectors. For example, 57% of diesel used in the EECA table's industrial sector is for transport, and 64% of petrol. We had to apply these ratios to all the manufacturing sectors to get fuel use related to transport only. By doing this, we assumed that the proportion of petrol/diesel use that is transport related is constant across all manufacturing sectors. This is unlikely to be true. This process could be improved if more comprehensive end-use data by disaggregated sector were available.
- We used the transport-related petrol/diesel use proportions in EECA's 'Agriculture' broad sector to adjust fuel use in the agriculture, commercial fishing and forestry and logging in Rousseau's data set.
- We used the transport-related petrol/diesel use proportions in EECA's 'Industrial' broad sector to adjust mining and quarrying, all manufacturing sectors, utilities and construction sectors.
- We used the transport-related petrol/diesel use proportions in EECA's 'Commercial' broad sector to adjust all service sectors, excluding transport and storage (no change for petrol)
- We used the transport-related petrol/diesel use proportions in EECA's 'Transport and storage' sector to adjust the transport and storage sector (no change for petrol use).
- This gave us transport-related petrol and diesel use by industry, over time.
- The next data manipulation process was necessary because in Rousseau's data set, the transport and storage (T&S) sector accounts for around 85% of total fuel use. Much of this will be carried out on behalf of other industries that don't have

their own transport fleets, etc. So, for example, 10% of the total amount of services provided by the T&S sector might be transporting forestry products. This means that the data underestimates the true amount of transport associated with each sector, as most of it is purchased from the T&S sector.

- To adjust the sectoral fuel use data to account for this, we use Statistics New Zealand's input output tables. Table 4 (inter-industry transactions) shows us who purchases transport services from the T&S sector. Using this information, we split the T&S fuel use figure across the other industries, to get a more realistic picture of the fuel use associated with each sector.
- We can then deduce fuel use by sector as:

$$Fuel\ use_i = \frac{Fuel\ use_i}{GDP_i} * GDP_i$$

- To isolate the impact of structural change, we held GDP constant at 1999 levels out to 2051. The change in fuel use out to 2051 is thus only due to structural change.
- By summing fuel use across sectors, we obtained total transport related fuel use to 2051 due to income growth (growth in real GDP) and structural change (change in nominal industry shares).
- This assumes that the elasticity of demand of real GDP to transport related fuel use is +1. The impact of income growth is that fuel use grows at the same rate as real GDP. This assumption could be varied in future analyses.

APPENDIX C: DETAILED DEMOGRAPHIC CHANGE METHODOLOGY

- The aim of this work was to identify what an ageing population might mean for household transport use.
- We know from Statistics New Zealand's *Household Economic Survey* (HES) data that expenditure on road transport varies between age cohorts. This is shown by the 'Vehicle ownership expenses' category of the 2001 HES.
- Note that we are not looking at public transport in this analysis. This is because the supply of public transport falls under the industry analysis. We are only interested in self-supplied household transport. Self-propelled household transport (walking, cycling) is not considered in the analysis at this stage.
- We needed to isolate fuel expenditure on road vehicles by age cohort. This is not available from Statistics New Zealand due to large sample errors. However, we know from HES data from 1987-1999 that across all age groups, the ratio of expenditure on the 'Fuel for road vehicles' sub-group to the 'Vehicle ownership expenses' group is around 56%.
- We applied this ratio across all age cohorts to the Vehicle ownership expenses data by cohort in the 2001 HES. This gave us each age cohort's expenditure on fuel for road vehicles in 2001.
- We then assumed that this expenditure stays constant over the projection period. This means that any change in expenditure over the projection period is due to the compositional shift of the population between cohorts.
- Our population projections are from Statistics New Zealand – from 2001, based on medium births, deaths and 5,000 net migration annually.
- However, actual migration for 2001-2003 was well above 5,000. Net PLT migration was 25,635 in the year to March 2002, and 41,592 in the year to March 2003.
- So we used our September 2003 *Quarterly Predictions* population projections for the 2001-2008 period to account for the migration inflows that differ from Statistics New Zealand's assumptions.
- We then rated forward the 2008 population number by the population growth from Statistics New Zealand's projections
- Finally we applied the projected cohort shares from Statistics New Zealand's initial projections to this updated population. This gives us the number of people in each age cohort out to 2101.
- By multiplying the number of people in each cohort by that cohort's HES road fuel use expenditure, and summing across cohorts, we get total road fuel use expenditure projections, due solely to demographic shifts.
- This analysis did not incorporate any income growth. To combine the effects of income growth and demographic change, the 2001 HES road fuel use expenditure numbers by cohort were inflated using real GDP growth. This assumes an elasticity of income with respect to fuel use of +1. This could be altered in future analysis.

- These figures were multiplied by the projections of the number of people in each cohort, giving us road fuel use expenditure by cohort out to 2101 taking into account demographic change and income growth.