Public transport patronage trends in New Zealand Where are all the passengers going?

Ian Wallis

Managing Director
Travers Morgan (NZ) Ltd
Wellington
NEW ZEALAND

Phil Yates

Senior Consultant
Travers Morgan (NZ) Ltd
Wellington
NEW ZEALAND

Abstract:

Public transport patronage in New Zealand has been declining by in the order of 10% per annum over the last few years. While this trend is of major concern the reasons for it have hitherto been unclear.

This paper reports an analysis of patronage trends of seven New Zealand municipal bus operators over the last 15 years. The major factors influencing patronage changes have been fares, service levels, car ownership levels, and population and employment levels. The models developed explain the recent patronage downturns and give demand elasticity values generally consistent with evidence from other New Zealand and international studies.

Contact author:
Ian Wallis
Travers Morgan (NZ) Ltd
P O Box 11-525
Wellington
New Zealand
Telephone: (04) 710 303 Fax: (04) 710 353

Introduction

This paper reports an investigation into trends in public transport patronage in New Zealand and the factors influencing these trends. The investigation was undertaken in early 1990 by Travers Morgan (NZ) Ltd for Transit New Zealand (the national land transport authority), as part of the NZ Urban Bus Study.

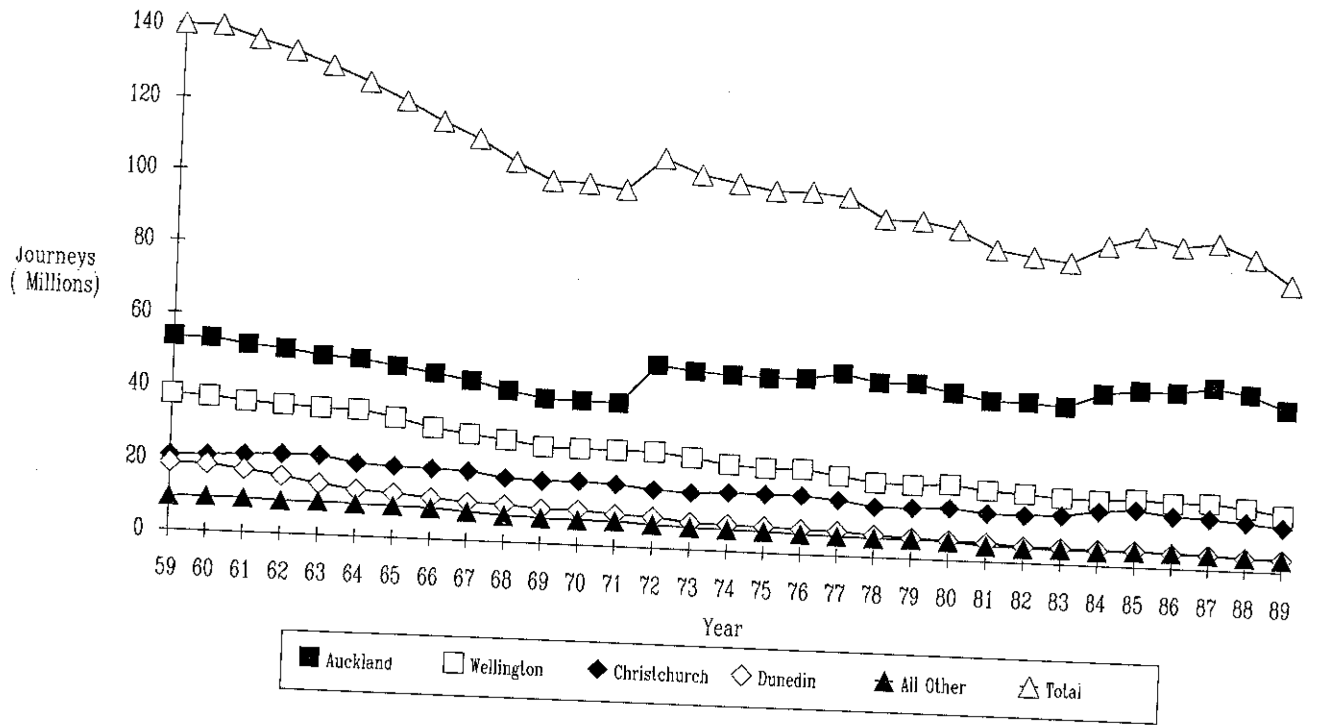
Trends over the last 20 years in patronage on urban public transport services in the 'western' world have differed considerably from country to country, with no clear-cut pattern behind these differences. Webster et al (1988) examined patronage trends over the 1970-1980 period in 15 'western' countries. They found that the actual trends in passenger journeys in the various countries varied between an average growth of 4.3% pa (Italy) and an average decline of 3.3% pa (UK). When the overall trends were standardised for different rates of change in subsidy levels, even more divergence between countries was found. Even after detailed analyses were undertaken which separated out the effects of obvious influencing factors (fares, service levels, car ownership, population, unemployment, urbanisation), the 'residual' trends in patronage varied between about +3% and -3% pa over the different countries. Australia exhibited the most negative 'residual' trend over this period (down 2.8% pa), followed by New Zealand (down 1.0% pa).

Despite these longer-term trends, in the late 1970's/early 1980's, the patronage of a number of major Australian and New Zealand urban operators stopped declining and, in some cases, increased significantly. As a result, it was thought in many quarters in the two countries, that the long term patronage trends might have 'bottomed out', that at worst the previous rate of decline would slow or cease and at best that there might be substantial patronage increases through the 1980's and 1990's. A number of optimistic forecasts were made to this effect. However, there appeared to be limited understanding as to why such a change from the previous long term downward trend should be occurring.

In New Zealand, the long-term downward trend had been continuing, with only few interruptions, since at least the late 1950's. Figure 1 illustrates this trend for the nine municipal bus operators, which account for the substantial majority of urban public transport travel in New Zealand. In the 24 years 1958/59-1982/83, total annual patronage declined from some 140 million to some 83 million, an average annual decline (compound) of 2.1% pa. However, the subsequent 4 years saw a recovery in patronage, up to 90 million in 1986/87. Operators and transport authorities became optimistic that perhaps the era of continuing decline was over and that they were dealing with a growth, or at least a stable, industry.

Such optimism no longer prevails, in New Zealand at least, and has been replaced with considerable concern about the future of the industry, in the light of patronage trends in the last three years. This concern has been reinforced by the current uncertainty associated with the introduction of transport law reform ('deregulation') throughout the industry in July 1991.

Figure 1 1959-1989 Passenger journeys - Municipal buses



Since 1986/87, the patronage of the New Zealand municipal bus operators has declined sharply: in 1987/88 by 4.4% average; in 1988/89 by a further 8.0% average; and in 1989/90 by over 10% in the case of two of the major operators (complete data not yet available). A continuation of the downward trends of the last two years could see the 1986/87 patronage levels halved by the mid-1990's.

Against this background, Transit New Zealand (previously the Urban Transport Council) commissioned the investigation reported here into the relationship between urban bus patronage in New Zealand and factors influencing the patronage: these factors were to include service levels, fare levels, population, unemployment, personal incomes, car ownership and car operating costs. (To our knowledge, no comparable investigations have yet been undertaken for Australian operators in recent years).

It was envisaged that the results would be valuable to planning authorities and operators in:

- explaining past trends;
- establishing differences in trends between areas;
- establishing demand elasticities (in relation to fares, service levels, etc);
- providing the basis for future patronage predictions and for assessing the impacts of different management, service and funding policies.

The remainder of the paper summarises this investigation and its findings. The next section describes the model formulation used, the data collected and the application of the model. Following sections describe the findings relating to the effects of the various variables on patronage, and then compare the findings with those from previous research on the topic The final main section examines the policy implications of the findings and draws conclusions.

Data and models

Coverage of project

The project involved collection and analysis of data on annual patronage and on factors thought to influence patronage, for the major municipal bus operators in New Zealand.

The project covered seven of the nine municipal operators - those in Auckland, Wellington, Christchurch, Dunedin, New Plymouth, Invercargill and Timaru. (The two municipal operators excluded were Palmerston North, for which insufficient data was available, and Gisborne). Table 1 summarises annual patronage, catchment area population and average trip rates for these centres for 1988/89.

Where possible, data was assembled for each centre for each of the 15 years 1974/75-1988/89 (1989/90 data was not available at the time of the investigation). In some cases complete data was not obtainable for the earlier years of this period.

Table 1 Summary of patronage and trip rates by centre, 1988/89

Centre	Catchment Population (000)	Annual Patronage (000)	Annual Patronage/ Population
Auckland	607	43,447	72
Wellington	103	15,523	151
Christchurch	322	12,106	38
Dunedin	73	3,399	47
New Plymouth	37	1,279	35
Invercargill	47	805	17
Timaru	27	355	13

Data collected

For each operator/centre and each year, the following data were collected or derived:

* Operator statistics:
  - Patronage
  - Bus kilometres
  - Fare revenue
* Area statistics (catchment area of each operator):
  - Total population
  - Car ownership - % households with:
    - 0 cars
    - 1 car
    - 2+ cars
  - Population/employment structure - % of population in group:
    - Age 0 - 4
    - Age 5 - 14
    - Age 15 - 60
      - full time students
      - employed, walk or cycle to work
      - employed, other CBD
      - employed, other non-CBD
      - employed, no trip to work
      - others not employed
    - Age 61+
* National statistics:
  - Personal income
  - Petrol price
  - Consumer price index

Substantial efforts were made to derive as consistent data sets as possible from these various data sources. Adjustments to figures provided by the operators were often necessary to derive a consistent time-series of data, eg to adjust for strikes, number of days in the year, end-of-year adjustments, inclusion/exclusion of charter services, etc. Household car ownership levels were derived from census data (5 yearly), with interpolation between censuses based on national car ownership data available annually. Similarly the population breakdown by age and employment type was obtainable only from census data (and required special tabulations); and intermediate years' figures were then derived by interpolation, using annual regional employment statistics.

Model formulation

The main analyses were undertaken for each of the 7 centres independently (a subsequent analysis derived average results over all centres). Two regression analyses on the annual data were undertaken for each centre. The first is a standard exponential time series formulation (referred to as the 'log' model); while the second uses a 'first-difference' formulation, based on the percentage changes in each variable from year to year (referred to as the 'delta' model).

The log model is as follows:

$$P = F^{\alpha} \cdot B^{\beta} \cdot I^{\gamma} \cdot R^{\delta} \cdot T^{\epsilon}$$

where:
- P is the patronage rate, measured as boardings per person per year, adjusted for car ownership and population structure
- F is the real fares level, measured as the average fare revenue per boarding
- B is the service level, measured as bus km per year
- I is the national real income level
- R is the real car operating cost, measured as real petrol price
- T is the index of the year
- α is the real fare elasticity
- β is the service level elasticity
- γ is the real income elasticity
- δ is the real car operating cost elasticity
- ϵ is the residual time trend.

The delta model uses the same terms and is as follows:

$$\frac{\Delta P}{P} = \alpha \cdot \frac{\Delta F}{F} + \beta \cdot \frac{\Delta B}{B} + \gamma \cdot \frac{\Delta I}{I} + \delta \cdot \frac{\Delta R}{R} + \epsilon$$

where ΔX represents the percentage change in variable X from one year to the next.

The adjustments of patronage per head for car ownership and population structure took the form of an index of 'underlying' public transport usage, derived by segmenting the population by household car ownership levels and by age/employment structure (segments as described above), and weighting each segment by known public transport usage levels. These relative usage levels for each segment were based on the results of household interview surveys undertaken in Wellington in 1988 (as part of the Greater Wellington Land Use and Transport Strategic Review): these results are discussed later in the paper.

The Auckland model was modified by the insertion of a further term representing the effects of the October 1987 stock-market crash.

Model application

The models track the major changes in patronage well in all of the centres modelled, although increases due to improved service (increased bus km) tend to lag behind the increase in service. Declines in service seem to be particularly well modelled and in every case the patronage declines of the last three years, including the large downturn in 1989, are adequately explained.

The log model has high multiple correlation coefficients, with R^2 values ranging from a high of 0.99 for Invercargill to a low of 0.88 for Christchurch. These high values of R^2 are expected from the form of the model, as both the dependent and independent variables are correlated with time. The delta model has lower R^2 values, ranging from 0.35 to 0.89. Again this is expected as the year-on-year changes tend to be far less correlated.

The Auckland case is different from the others in that it appears to have a two-part time trend, made up of an increasing trend to October 1987, followed by a sharply decreasing trend (represented by a dummy variable in the regression). A constant trend does not produce sensible results in this case. It is suggested that the change in trend after October 1987 is related to the stock-market crash (which occurred in that month) and its effects on employment, particularly in the CBD, and on the availability and price of car parking.

For nine months of the 1979-80 year, New Zealand had a scheme whereby each car was prohibited from use for one day per week. This 'carless day' scheme appears to have had some impact on public transport use in these centres, with an average public transport usage around 3% higher in this year than the model expectations. (This increase is relatively small, due to the large increase in two-car families over this period and the promotion of car-pooling schemes.)

The model results

This section summarises the results of the modelling under three sub-headings:

* Elasticity of demand
* Car ownership and population/employment structure effects
* Contributions of individual factors to patronage changes.

Elasticities of demand

'Elasticity of demand' with respect to service features or other variables is a well-known concept in analyses of travel demand. The elasticity essentially measures the relationship between the proportionate change in public transport patronage and the proportionate change in a causal variable (eg, fares). A typical fares elasticity of demand is -0.3, which implies that a 10% increase in fares results in a 3% loss in patronage.

Table 2 summarises the average elasticities (over all seven centres) found from the model analyses. Also included are the standard errors on each of these estimates.

The following discussion of the results focuses on the average values of each variable over all centres. Further details of the results for individual centres are given in the project report (Travers Morgan, 1990).

Fares:

The real fares elasticities from the two models, averaged over all centres, were similar:

- log model -0.34
- delta model -0.32.

The log model estimate is significantly different from zero at the 95% confidence level, while the delta model estimate is nearly so.

Most of the fares elasticity values for the individual centres are significantly different from zero and are generally consistent between the two models. Few of the individual centre values are significantly different from the overall average values. The mean estimates for the major centres include:

- Wellington -0.63 (log), -0.47 (delta)
- Christchurch -0.45 (log), -0.43 (delta)
- Dunedin -0.43 (log), -0.47 (delta).

Table 2 **Average elasticity of demand values**
Average of 7 centres[1]

Variable	Elasticity of Demand	
	Log Model	**Delta Model**
Real fares[2]	- 0.34 (0.16)	- 0.32 (0.23)
Service level[3]	+0.54 (0.47)	+0.48 (0.51)
Real income[2]	- 0.20 (0.47)	- 0.17 (0.62)
Real petrol prices[2]	+0.07 (0.11)	+0.07 (0.12)
Time trend (residual)	- 0.004 (0.004)	- 0.014 (0.012)

Notes:
(1) Figures in brackets are standard errors on each mean value
(2) 'Real' variables are adjusted by the national CPI
(2) Measured by total bus kilometres operated

Service Levels:
The annual bus kilometres operated on route services was taken as a proxy for the 'service levels' provided in each centre. The average service level elasticities for all centres were:

- log model +0.54
- delta model +0.48

These estimates have a considerable standard error associated with them and neither is significantly different from zero at the 95% confidence level. None of the service elasticity values for the individual centres is significantly different from the overall average values (at the 95% confidence level). (The lack of significance of these results is largely a reflection of the very limited changes which have occurred in bus kilometres in most centres over the period analysed).

Incomes:
The real income elasticity measures the proportionate change in patronage as a result of a change in real personal income (as measured by average post-tax incomes). This effect is additional to the effect of income on car ownership, which is generally more pronounced. Expectations were for a positive income elasticity, indicating for a given level of car ownership that patronage tends to increase as real incomes increase.

The results (Table 2) indicate a small negative income elasticity, of about 0.2. However, this is not significantly different from zero, even at a low level of confidence. It may well be that this negative result arises because the model is not adequately separating out the income effect and the car ownership effect (which is allowed for separately).

The only income elasticity result which was significantly different from zero (at the 95% confidence level) was that for Wellington in the log model. This is +0.50

(with standard error ± 0.24), which is of the expected sign.

Petrol prices:
Real petrol prices have been taken as a proxy for the (perceived) costs of running a car, representing the main alternative mode to bus travel.

Table 2 indicates very low positive elasticities (+0.07) with respect to petrol prices. These results indicate that a 10% petrol price increase would lead to a 0.7% increase in bus patronage, ie, a very inelastic response. This result is of the expected sign, but is not significantly different from zero, even at a low confidence level. The same comment applies to the results for each of the individual centres.

Time trends:
The time trend 'elasticity' value represents the annual percentage unexplained trend in patronage, after the effects of all the other variables have been allowed for. The results (Table 2) represent an average 'unexplained' patronage trend of approximately 0.4% pa downwards in the log model, approximately 1.4% pa downwards in the delta model. The all-centres average trends are not significantly different from zero. On the log model, the best estimates for individual centres all lie in the range between -1% pa and +1% pa.

Car ownership and population/employment structure effects

As noted earlier the estimated effects of changes in car ownership and population/employment structure on total patronage were estimated outside the main regression model formulation. Data on relative public transport trip rates by different household car ownership levels and by different age/employment categories were first derived from a household interview survey undertaken in Wellington in 1988. These **relative** trip rates on the propensity to use public transport were assumed to remain valid throughout the 15 year analysis period; so that the effects of changing car ownership and age/employment structure on public transport usage over the period could be isolated. (There would have been a number of statistical difficulties in including these effects in the main regression model, and likely to be strong correlation between the car ownership level and time, making it difficult to separate the two effects).

Car ownership:
Table 3 summarises average daily public transport trip rates for households in different car ownership categories, based on the Wellington data. It is apparent that there is a major reduction in public transport trip-making with acquisition of the first household car, a much lesser reduction with addition of subsequent cars.

For the centres and time periods analysed, the effects on patronage of the car ownership changes were estimated, and hence an equivalent average response sensitivity was derived. It was found approximately that:

- Each 0.01 cars/head increase resulted in a patronage loss of about 1.4%.

Table 3 Public transport trip rates by car ownership category
Average daily trip rates, based on Wellington GATS data

No. of Cars/Household	Average Daily Public Transport Trip Rate (Trips/Household)
0	1.61
1	0.97
2	0.90
Average	1.00

Table 4 Public transport trip rates by age and employment category
Average daily trip rates, based on Wellington GATS data

Age/Employment Category		Average Daily Public Transport Trip Rate (Trips/Person)
0- 4		N/A
5-14		0.40
15-60	- full time students	0.86
	- walk/cycle, employed	0.21
	- other CBD employed	0.81
	- other non-CBD employed	0.18
	- other employed (no work trip)	0.10
	- other not employed	0.24
61+		0.21
Average all groups		0.39

- A 1% increase in cars/head resulted in a 0.7% loss of patronage, indicating an equivalent average car ownership 'elasticity' of -0.7.

Population/employment structure:
Table 4 summarises average public transport trip rates by age group and employment group, based on the Wellington data.

The most striking feature of this data is that trip rates for people employed in the CBD and for students are very much greater than for all other categories, with the differences in trip rates between these other categories being relatively small. Typically a change in status of one person from a CBD employee in Wellington to any other category (except student) would result in a public transport trip loss of about 0.6 trips/day or some 220 trips per year.

In centres such as Wellington, which have relatively high public transport usage and a major proportion of its employment in the CBD, a 1% loss in CBD employment would result in a patronage loss of about 0.2%. This indicates an equivalent average CBD employment 'elasticity' of 0.2.

Contributions of individual factors to patronage changes

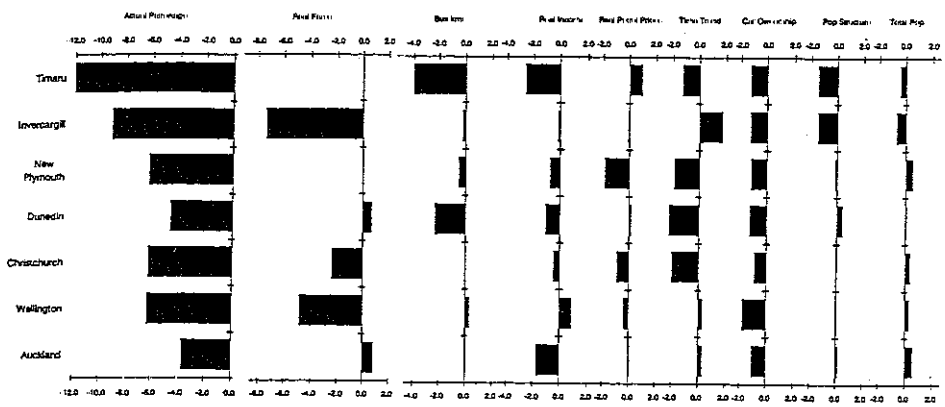
This section describes the model findings in terms of the contributions of the various factors to the total change in patronage in each centre over the periods analysed. For this purpose, results have been derived for three periods:

- 1975/76 - 1988/89 (13 years - long term)
- 1980/81 - 1988/89 (8 years - medium term)
- 1985/86 - 1988/89 (3 years - short term).

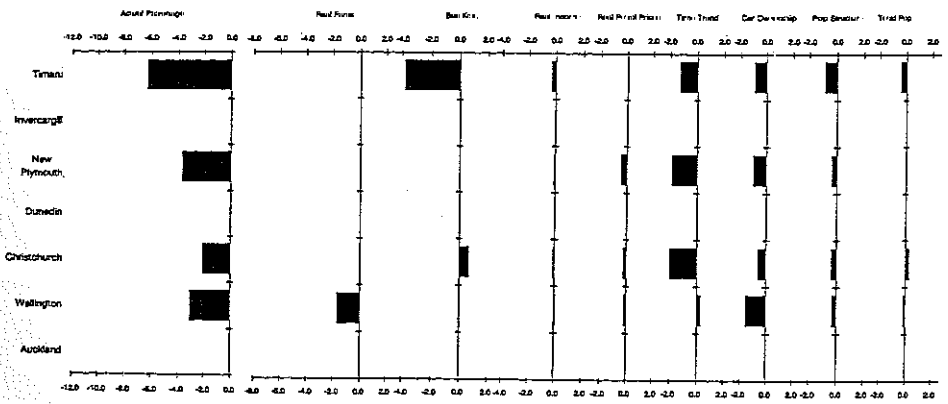
Figure 2 shows the average annual contribution of each factor to the patronage changes in each centre over the short and long term periods. Due to the data gaps, results are not available for all centres for the long term analysis. The results quoted are based on the log model (broadly similar results were found with the delta model). The key findings for the three periods are summarised as follows:

Short term (1985/86 - 1988/89):

* Increases in real fares have been the largest single cause of the patronage decline in three centres:
  - Invercargill - contributed 7.4% pa of the average patronage loss of 9.1% pa.
  - Wellington - contributed 4.8% pa of the average patronage loss of 6.3% pa.
  - Christchurch - contributed 2.4% pa of the average patronage loss of 6.2% pa.
* Car ownership increases have caused a patronage decline of 1-2% pa in most centres.
* Changes in population/employment structure have caused a patronage decline of between zero and 1.5% pa in most centres. In most centres (except Invercargill and Timaru) this factor has been largely offset by the increase in total patronage in the catchment area.
* Time trends (unexplained) account for a further decline of 1-2% pa in four centres, but are positive in three of the centres.
* Service levels (bus kilometres) appear to have been significantly associated with patronage decline only in Timaru (caused an average 4% pa patronage decline) and Dunedin (caused a 2% pa decline). However, it is not clear that these are causal relationships: it may be that the reduction in service levels is partly a response to decreasing patronage, rather than necessarily a cause of it. In most other centres the change in bus kilometres over the period has been very small.



Short term period (1985/86 - 1988/89) average % change per year



Long term period (1975/76 - 1988/89) average % change per year

Figure 2 **Components of patronage by centre**

Medium term (1980/81 - 1988/89):

* Increases in car ownership (causing a 0.9-1.7% pa average patronage decline) and unexplained time trends are the major causes in most centres of the patronage changes since 1980/81.
* In most centres changes in population/employment structure have made only a small contribution (generally positive) to patronage changes, while total population has also increased slowly.
* In some centres, reductions in service levels have been a major cause of patronage loss (Timaru c. 4% pa loss, Dunedin c. 2% pa loss), while in Christchurch service increases have contributed to patronage increases (1.0-1.5% pa gain). However, the same caveat as above applies concerning cause-effect relationships.
* Wellington is the only city with significant real fare increases over this period, causing an average patronage loss of c. 1.5% pa; while real fare reductions have contributed to increased patronage in Dunedin and, to a lesser extent, Christchurch.
* Any effects of petrol prices and incomes are small in comparison with the other factors identified.

Long Term (1975/76 - 1988/89):

Full data was only available for four centres over this period (Wellington, Christchurch, New Plymouth, Timaru).

* As for the medium term, the major contributory factors are car ownership and the (unexplained) time trend. Together these typically account for a 1% - 3% pa decline in patronage over the period.
* Changes in population/employment structure contributed between 0.3% and 0.9% pa to the patronage declines in each centre.
* The total effects of changes in real fares and service levels vary between centres. For instance, in the two larger of the four centres:
  - Christchurch : service increases have been associated with average patronage gains of 0.8% pa; fare changes have had a very small impact.
  - Wellington : fare increases have resulted in average patronage losses of 1.7% pa; service level changes have had a very small impact.

In **summary**, over the longer-term period the major factors contributing to the patronage decline have been:

* Car ownership increases.
* Unexplained 'time trends', which may well reflect changes in social habits, increased suburbanisation, etc, which are not captured by the other model factors.

Changes in real petrol prices and real incomes over the period have had very small impacts.

Factors within the influence of transport management (fares, service levels) have had substantial impacts in individual centres over the longer period, but in

most cases have not changed very much. However in the short/medium term these factors have changed more rapidly, with generally adverse effects on patronage. In the short term, increases in real fares have had the largest single adverse impact on patronage in three centres (Invercargill, Wellington, Christchurch) and service reductions have also been associated with substantial patronage losses in two centres (Dunedin, Timaru)

Comparisons with previous work

The section presents a brief comparison of the foregoing findings with findings from previous studies on the demand for public transport, both in NZ and overseas. This draws on the results of an international literature review undertaken as part of the project. These comparisons are made under three headings:

* Response to public transport variables
* Response to private transport variables
* Response to other variables.

Response to public transport variables

Table 5 presents a summary of the NZ and international evidence on the elasticities of demand for urban public transport with respect to fares and to service levels (generally measured by bus kilometres). The previous NZ evidence on these issues is rather limited, but is generally not inconsistent with the range of evidence found in overseas studies.

The project's average **fares elasticity** of around -0.33 is very consistent with the values found in overseas studies (the 'standard' international elasticity is -0.3). The fares elasticity estimates in the individual centres are almost mostly within the range of values found in international studies. In this aspect the study results are fully consistent with prior expectations.

The project average **bus kilometre elasticity** of around 0.5 is also fully consistent with the results of previous international (and NZ) studies and with prior expectations. Most of the elasticity values for individual centres are also within the expected range. It should be noted that the values derived in this study and most of those found in other studies may be on the high side of the 'true' values, due to the difficulties in separating cause and effect in the analyses.

Response to private transport variables

The response of public transport patronage to changes in private transport availability and operating costs is much less well studied (both in NZ and

Table 5 Fare and service elasticities - Summary of other evidence[1]

Source	Fares Elasticity	Bus Kilometres Elasticity
New Zealand		
Christchurch Buses (1975-89)	-0.45	0.4 to 0.5
Auckland Buses	-0.24	0.67[2]
26 NZ Urban Areas (1981)	-0.13	1.0
Wanganui Buses (1978-85)	-0.6	0.7
Wellington Rail (1970-85	-0.3 to -0.4	0 to 0.5[2]
International		
'Standard' values[3]	-0.2 to -0.4 (generally c. -0.3)	0 to 0.8 (generally 0.2 to 0.6)
Market segments with higher than average (absolute) elasticity:	• Smaller towns • Off-peak/leisure trips • Shorter trips	• Lower frequency services • Off-peak/leisure trips.

Notes: (1) Refer Project Report (Travers Morgan 1990) for further details and sources.
(2) Subject to particular uncertainty because of the unrepresentative nature of the service changes involved.
(3) These represent the range of values most commonly found in international studies.

internationally) than is the response to fare and service level changes.

In relation to **car ownership** there is a wide range of previous evidence. In NZ, Galt and Eyre estimated demand elasticities with respect to cars/household of -4.6 (evidence from 26 urban areas) and with respect to total cars owned of -2.0 (Wanganui data only). These values both seem unreasonably high. Internationally, in UK and France it is estimated that public transport trips per person decline by approximately 45% on acquisition of the first household car, and by a further third with acquisition of the second car. The trip rate figures used for this study (Table 3) are reasonably consistent with this pattern. The indicative car ownership 'elasticity' derived in this study (-0.7) is of the same order as Australian evidence of elasticities of -0.25 for work trips, -0.7 for other trips.

In relation to **car operating costs**, the overseas evidence on any effects of operating costs on public transport patronage is inconclusive. While various studies have estimated elasticities in the range 0.2 to 1.4, most evidence points to them being at the low end of this range, or even lower. Of two relevant NZ studies, one estimated an elasticity of 0.09 with respect to total car operating costs, one found no significant effects.

The study finding of very small positive elasticities (0.07), but not significantly different from zero, is not inconsistent with expectations.

Response to other variables

Evidence from other studies on the effects of other variables (income, employment etc) on public transport patronage is rather limited and patchy, and very limited in NZ.

In relation to **real incomes**, overseas evidence is for elasticities in the range 0.1 to 0.8, after separating out the effects of income on car ownership. Some NZ data (Wanganui) suggests an elasticity of about 0.25. The study estimates are about -0.2, but with a considerable margin of uncertainty. While the negative sign is contrary to expectations, there is a quite high probability that the true result would be positive.

In relation to the effects of employment levels and locations, there is almost no previous evidence in NZ and very limited evidence reported from overseas. However, the relative trip rates obtained for this study (Table 4) are broadly consistent with UK evidence on the effects of unemployment on patronage.

Conclusions and policy implications

Success of the modelling approach

In general, given the limited data sets for each centre, we consider the quality and consistency of the model results was high, inasmuch as:

- The model formulations explained a large proportion of the patronage changes in each centre.
- In particular, the models were largely successful in accounting for the substantial patronage declines of the last few years.
- The log and delta models gave generally consistent results.
- The model results for the various centres (in terms of elasticity values etc) were generally consistent with each other.

Response of patronage to different factors

The patronage response to different variables is represented by the elasticity of demand measures. As discussed earlier, the estimates obtained were mostly consistent with those found in other studies, and also generally consistent across the different centres.

Contributions to patronage changes

Over the full 15 year period examined, the major contributors to the observed patronage decline have been:

- Increases in car ownership
- Changes in population/employment structure, particularly a reduction in the proportion of CBD employment
- 'Residual' time trends (not covered by other model factors).

Changes in real petrol prices and real incomes have had very small impacts over the longer period. Over the longer period, factors within the influence of transport management (fares, service levels) have had substantial impacts in some centres, but in most cases have not changed very much. However, in the last few years these factors have changed more rapidly, with generally adverse effects on patronage. In particular, increases in real fares have been the single factor having the largest adverse impact on patronage in three of the seven centres (Wellington, Christchurch, Invercargill).

The greater patronage decline over the last few years compared with the trends in the early/mid-1980's results from adverse combinations of factors, and principally:

- real fare increases
- service reductions (some centres)
- car ownership increases
- changes in population structure, particularly reduced CBD employment
- 'residual' time trends.

Policy implications

The project did not examine the broader transport policy implications of the model results, although some further work has been undertaken subsequently. Some initial comments are given here.

* Future increases in car ownership are likely to cause a continuing decline in public transport patronage. These trends are likely to be exacerbated by the recent fall in NZ car prices (as a result of tariff reductions), the effects of which are not fully reflected in the periods analysed in the study.
* The adverse trends are likely to be exacerbated by any further decrease in employment rates, by any further decentralisation of employment and by the ageing of the population.
* These adverse trends could be partly offset by overall population growth, but any growth in the established urban areas served by the municipal operators appears likely to be small (if not negative).
* Changes in petrol prices and real incomes are likely to have only very small effects on patronage levels (apart from the effect of real incomes on car ownership).
* More restrictive parking policies, particularly in the major urban centres, could

help to increase public transport patronage, but are also likely to result in increased subsidy requirements.

* As a result of the above factors outside the influence of transport operators, a continuing 'underlying' patronage decline is likely, probably in the range 1-4%pa for most centres.
* If real fares and levels of service are not changed, the result would be a continuing decline in cost recovery and a need for increased subsidy support.
* Real fare reductions and/or level of service increases would help to retain patronage levels, but would result in further increases in subsidy requirements.
* Real fare increases and/or level of service reductions would help to contain or reduce subsidy requirements, but would result in increased rates of passenger loss (as has occurred in the last few years).
* For a given level of subsidy, the optimum balance between fares and service levels to achieve maximum patronage would need to be considered further, on a case-by-case basis but within a general analytical framework.

The effects of the forthcoming 'deregulation' of passenger transport on patronage levels and subsidy requirements are not clear at this stage. However, the present indications are that deregulation will be associated with a substantial increase in real fare levels in some centres, as well as a one-off reduction in unit operating costs among the municipal operators in particular. Together these would result in a substantial cut in subsidy requirements from central/regional government. However, the higher real fares together with the inevitable public uncertainty about changes in services on deregulation are likely to further reduce patronage, at least in the short-term.

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