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Understanding Underlying Constraints Affecting Decision-Making by Morning Car Commuters

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TITLE: Understanding Underlying Constraints Affecting Decision-Making by Morning Car Commuters.

ABSTRACT: In New Zealand as elsewhere, there is an increasing interest in alleviating congestion on the road transport network to improve economic productivity, reduce pollution, and to use the transport network more effectively. Governments enact various policies to encourage car drivers to change their behaviour, but often find that the full impact is not reached. We propose that car drivers have constraints influencing their mode choice for the morning peak period trip. A stated preference experiment conducted in the three largest New Zealand urban areas identifies these constraints and their impact on a series of policy initiatives designed to influence car driver behaviour.

KEY WORDS: Driver behaviour, travel behaviour, stated preference, decision-making, constraints, peak period, mode choice.

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1. Introduction

In New Zealand, as elsewhere internationally, there is an increasing interest in alleviating congestion on the road transport network, thereby improving economic productivity (by reducing the amount of productive employee time spent sitting in traffic), reducing air pollution, particularly carbon monoxide and CO_2 emissions, lessening noise and water run-off impacts, and making more efficient and effective use of the road network. The New Zealand Government has recently announced[1] policy changes to expand passenger transport services and encourage passenger transport use, developing a walking and cycling strategy (aiming to increase both activities), allow more tolling of roads and to introduce electronic road user charging. The Government announced it would investigate further the option of congestion charging based on time and location of travel. To impose tolls or congestion pricing, regional councils in Auckland, Wellington and Christchurch have previously identified where a cordon could be placed around the central city areas in their respective regions.

But how well will proposed policy changes meet their objective of alleviating congestion by reducing car use? Changes in transport policy or the conditions of a passenger transport service may not have their expected impact because policy makers do not understand the constraints affecting an individual's travel choices. The need for research to understand the impact of policies has been recognised by organisations such as the European Commission (1996), the US General Accounting Office (1996) and researchers (see for example, Rosenbloom, 1998).

As part of a larger research programme entitled "Identifying Factors to Change People's Transport Use", carried out by Pinnacle Research and its collaborators and funded by the Foundation for Research Science and Technology in New Zealand, we have undertaken stated preference experiments in Auckland, Wellington and Christchurch to explore the potential effect of several different policy measures on the respondent's decision to choose to drive a car to work or their own place of study in the morning peak period (before 10 a.m.). At the same time, we collected information on various factors that we considered might influence mode choice, such as vehicle ownership, gender, age, use of car during the working day, household composition, and so on.

Stated preference experiments present a "choice setting" in exactly the same way as the individual currently sees it (in this case, the usual morning journey to work or place of study) but alters some of the conditions (by introducing one or more of the policy measures) under which the choice is made, thereby allowing us to observe the potential effect of the policy measure (see Louviere et al 2000). Beaton et al. (1998) cited two studies showing reasonable external validity in predicting mode choice. In addition, they demonstrated good external validity for predicting switching from single occupant vehicles to a new passenger transport service in their own small study. There is also a substantive body of social psychology literature demonstrating the link between stated intentions and actual transport behaviour (refer to Baldassare et al. (1998) for additional references).

Multinomial logit and nested logit models are estimated that incorporate the attributes of the stated choice experiments as well as contextual effects (external factors) influencing

[1] *Moving Forward* (February 2002)

choice. The resulting models are not used to predict demand but instead allow us to identify the variability in mode share between a range of policy scenarios.

2. Survey Design and Methodology

2.1 Stated Preference Experiment Design

We conducted our stated preference (SP) experiment in the three main urban centres in New Zealand: Auckland, Wellington and Christchurch. Standard random household sampling techniques were used to find car drivers who drove to their workplace or their own place of study before 10 a.m. at least twice a week. Respondents were interviewed face-to-face. The Auckland and Wellington interviews were conducted in mid-1999, while the Christchurch ones were conducted in mid-2001. We had a total of 732 completed valid questionnaires: 247, 233 and 252 in Auckland, Wellington, and Christchurch respectively. Close to 1400 households were classified as “ineligible” and the refusal rate averaged about 40% in the three cities.

The stated preference experiment had 11 policy tools which, when in place, could affect the decision to drive a car to work or study. As can be seen from Table 1, five of these policy tools could be considered to target reducing car use directly, five could be seen as promoting or encouraging passenger transport use, and the remaining one as encouraging cycle use. Ten of the 11 policy tools were presented in each city – Auckland and Wellington had all of the car use and passenger transport tools while Christchurch respondents were presented with the cycling option and only 4 of the 5 passenger transport attributes. Each policy tool had three levels (see Table 1). The levels used in Auckland and Wellington were higher than in Christchurch for three of the car use tools, reflecting the fact that parking is currently much less expensive in Christchurch and, as a more “provincial city,” the traffic congestion problems in Christchurch are much less significant than in the other two cities.

Table 1 Eleven policy tools and their respective levels for use in stated choice experiment (Levels in brackets are those used in Christchurch survey)

Tools to Reduce Car Use	**Level 1**	**Level 2**	**Level 3**
Extra daily parking charge on car park buildings and lots	None in place	\$5 / day (\$2.50 / day)	\$10 / day (\$5 / day)
Restricting on-street parking to ≤2 hours within a nominated radius of work / study place	No change	Within 0.5 km = ≤P120	Within 1.5 km = ≤P120
Converting all on-street parking within a 1 km radius of work / study place to metered parking	No change	\$2.50 / hour (\$1.25 / hour)	\$5.00 / hour (\$2.50 / hour)
Cordon charge to enter central city before 10 a.m.	None in place	\$5 each entry (\$2.50 each entry)	\$10 each entry (\$5 each entry)
Vehicle registration surcharge per km driven	None in place	10¢ / km	30¢ / km
Tools to Increase Passenger Transport Use			
Improved frequency of services during peak hours	No change	50% more often	Twice as often
Lower passenger transport fares	No change	25% decrease in cost	50% decrease in cost
Improved / shortened trip times of services (e.g. through ticketing improvements, preferential bus treatment at intersections, etc)	10% better	25% better	35% better (including HOV lane)
Improved route coverage of services	No change	Bus stops within 400m of home and work place	Bus stops within 800m of home and work place
Increased off-peak services	No change	Services every 15 minutes during off-peak	Services every 30 minutes during off-peak
Tools to Increase Cycle Use			
Cycle Lane Availability	No change	Along 50% of route to work / study	*Along 100% of route to work / study*

Thus, the SP design for each city had ten attributes each of three levels. A full factorial design (i.e., all combinations) produces 59,049 possible combinations (3^{10}). A fractional factorial design was used to create 81 scenarios in which all ten main effects were independent and orthogonal. SP designs are typically defined as a fractional factorial in order to preserve as much as possible of the statistical variability offered by the full factorial while recognising the practical necessity of having the exercise manageable by respondents (Louviere et al., 2000). The 81 scenarios were randomly ordered and then equally divided into 9 separate booklets.

Each respondent was presented with 9 different scenarios and asked "if all these changes were in place on that day, how would you have travelled to work or your place of study?" An example of an SP choice scenario is shown in Figure 1. "That day" refers to a day in the previous week for which the respondent had been asked to provide trip diary details. The interviewer coded the open-ended response on the survey form. In the analysis, we coded seven "mode" choices for each trip:

(1) drive a car (Drive)
(2) become a passenger in a car (Passenger)
(3) arrange car pooling (Carpooling)
(4) walk and catch public transport (walkPT)

(5) drive, park and ride public transport (drivePT)
(6) cycle (Cycle)
(7) other (including walk, work from home for some or all of the day, taxi, change time of trip).

Figure 1 Example of Stated Preference Scenario (Auckland and Wellington)

PARKING …	
1. Extra charge in a carpark lot / building (one where you already pay)	$5 extra per day
2. On-street availability	no change
3. On-street charges	all on-street parking within 1.0 km of your work/study place costs $2.50/hr and strictly enforced
PRIVATE VEHICLE …	
4. Registration increase	10c/km (= $1000 per 10,000 km driven)
5. Fee to enter central city up to 10AM	none in place
PUBLIC TRANSPORT (trains/buses/ferries)	
6. Frequency	runs twice as often
7. Fares	costs half as much
8. Trip time changes	shorten bus trip time by 25% (e.g., priority signalling, quicker ticketing, fewer stops)
9. Route coverage	no change
10. Hours of operation	service runs at least every 15 minutes during off-peak hours up to 10pm

These seven mode choices later became the basis for our multinomial logit and nested logit modelling.

In addition to the trip diary for one day and the 9 stated choice scenarios, demographic and other personal information about car use (and cycling in Christchurch) was sought, along with the responses to several attitudinal statements about passenger transport, car driving, ridesharing (and, in the case of Christchurch, cycle use). All of the data collected has proved useful in informing an understanding of the constraints drivers face when making travel decisions.

2.2 Other Factors in the Survey

The stated preference data was enriched with other covariates that were not part of the stated choice experiment but which may be important influences on mode choice. These contextual effects include:

- car use for work-related trips during the business day
- parking costs in the past week
- employment status
- driver's age and gender
- household composition
- car ownership

- transporting children to school
- number of trips / stops before work
- location of work / study place (i.e. in central city or other suburb)
- roundtrip distance (in km), from home to work and/or study place to home
- household income (Christchurch only).

2.3 Mode Choice Modelling

The modelling task was to model mode choice, taking into account both the responses to the SP scenarios and the information collected on the contextual effect. In order to make comparisons between the three urban centres, we developed separate models for choice of mode using stated preference and the above-named covariates. Initially, we derived multinomial logit models for each city and then attempted improve on these by constructing nested logit models. In the case of Wellington and Auckland, the final models are multinomial logit models. The Christchurch model is a nested logit model, chosen from a number of tree structures. It has one branch consisting of the Drive, walkPT and Cycle mode choices while the other branch incorporates the Carpooling, Car passenger, drivePT and "all other" mode choices. The nested logit model has inclusive value parameters lying in the 0-1 range, thus meeting the condition for consistency with utility maximisation (Louviere et al., 2000).

3. Results

3.1 Mode Choice and Mode Share

As indicated previously, we had 732 respondents in Auckland, Wellington, and Christchurch who each responded to 9 scenarios. This provided 6,581 cases for analysis (7 cases were deleted because a clear choice of a single mode was not made).

Nearly one-half (48%) of the sample *always* chose to continue to drive their car (Drive) in response to the scenarios presented them. The respondents were very evenly distributed among the three cities. Those who always chose Drive were more likely to be male, self-employed (students were more likely to switch modes), drive a company or business vehicle and to use their car during working hours for business-related trips. Note that this common choice of the Drive throughout occurred despite the levels of extra cost involved with some of our policy tools being sufficiently high as to provoke extreme concern and even anger that such options might be being considered (as shown by many spontaneous respondent comments recorded at the end of the interview).

The remaining 52% chose an alternative mode of travel for at least one scenario. Table 2 reveals that, in all three cities, the primary alternative mode chosen was walk and ride passenger transport (walkPT). Beyond this, however, there was no consistent pattern of mode choice, reflecting the differing nature of the alternatives to car driving available in the three centres. In Wellington, the alternative mode most preferred after walkPT was to drive, park and ride passenger transport (drivePT). In contrast to Auckland and Christchurch, the drivePT option is widely available (at commuter rail stations) in the Wellington region and there is clearly a reasonable level of awareness of it. In Christchurch, with its flat terrain and wide streets, choosing Cycle is a much more viable option than in the narrow, winding and hilly streets of Wellington or the much more traffic-congested streets of Auckland. In Auckland, reflecting the generally lower levels of passenger transport service provision, busier streets and more dispersed population, more car drivers viewed Carpooling with someone else as a viable alternative to driving their own car or using passenger transport.

Table 2 Mode Chosen (by City) in Response to Scenarios (% - may not add to 100 due to rounding)

	Auckland	Wellington	Christchurch	Total
Drive car	72	64	66	67
Become a car passenger	2	2	2	2
Car pool	2	1	0.5	1
Walk & take PT	18	24	22	21
Drive, Park & Ride PT	2	7	1	3
Cycle	2	0.2	6	3
Other (taxi, walk, work from home, change trip time, etc)	4	2	3	3
Total number of scenarios	n=2219	n=2094	n=2268	n=6581

The small number of respondents choosing some modes meant that we had insufficient data to estimate the utility function for that mode in detail (i.e., beyond simply fitting a constant). This was the case for the following modes:

- drivePT in Christchurch and Auckland
- Cycle in Auckland and Wellington
- Carpooling / ride sharing in Wellington and Christchurch
- Car passenger and "All other [modes]" in all three cities.

3.2 Mode Choice Modelling: Design Variables

As can be seen in Table 3, all five of the policy tools designed to directly affect car driving are significant in all three cities. Better model fit was obtained by using slightly different utility functions for different cities. For example, a single dummy variable was used to reflect extra charges in carpark lots/buildings in Auckland and Christchurch because overall model fit was not significantly improved by using variables which reflected different levels of the extra charges, whereas in Wellington significantly better model fit was obtained using a variable reflecting the level of the extra charges in dollars.

The impact of policy tools improving passenger transport services was often not detectable to a statistically significant extent. Only the following tools showed a significant impact on choice:

- In Auckland and Christchurch, the provision of a bus / high occupancy vehicle lane to reduce trip times by 35%
- In Wellington, increasing frequency of services in the peak period
- Improving the routing of services in Auckland (to within 400m of the home and work/study place).

Reducing passenger transport fares and increasing the frequency of services in the off-peak period were not significant in any city. In a UK study of car drivers and possible policies to attract them out of their cars for short trips, Mackett (2001) found that only 1% of car drivers wanted passenger transport to be made less expensive in order to get them to use it. The main actions required to increase use of passenger transport were to improve the routing of services and the frequency.

In Christchurch, the possible increase in provision of cycle lanes did not have a significant effect in encouraging car drivers to switch to Cycle. This result is not surprising given the experience of both Germany and the Netherlands over the period from 1976 to 1995. During this time, the Netherlands effectively doubled the length of its cycle paths and lanes from 9,282 km to 18,948 km while Germany almost trebled its network from 12,911 km to 31,236 km. These dramatic changes in the network resulted in cycling simply maintaining its (admittedly high) "market share" of all trips by all modes (27%) while the German share increased from 7 to 12% (Pucher and Dijkstra, 2000). Our proposal to increase the availability of cycle routes along a limited route (from the respondent's home to work or study place) is quite minor and thus, far less likely to have any significant impact. Mackett (2001) had findings similar to ours: only 2% of UK drivers said they would cycle if improvements to cycle facilities were made. Possible improvements to cycling facilities included more cycle lanes, street lighting and showering facilities at work.

3.3 Mode Choice Modelling: Contextual Variables

The results show that many factors sway mode choice for the trip to work or study in the morning. These reflect important constraints on mode choice.

We found that employment practices strongly influenced mode choice. In particular, the provision of company-owned vehicles, employer-provided parking (regardless of whether or not some of the costs of parking were met by the employee), and/or the need to use a car during the day for work-related business resulted in a strong likelihood that a respondent would choose Drive regardless of how much the cost was increased (to the levels used in this design). It is possible that respondents felt that their employer would absorb the increased operating or parking costs, or perhaps would not be affected by it.

Table 3 Final Mode Choice Models for Auckland, Wellington and Christchurch

		Auckland	**Wellington**	**Christchurch**
Type of Model		Multinomial logit	Multinomial logit	Nested logit
Car Driver				
Extra charge in carpark lot/building	Dummy (1=$2.5 - $10/day)	-0.3566 (-4.1) [s]		-0.7495 (-4.7)†
	$5 or $10 / day		-0.0560 (-4.8)	
On street parking availability restricted to < 2 hrs (0.5 or 1.5 km)		-0.3566 (-4.1) [s]	-0.2629 (-2.3)	-0.5597 (-2.8)
On street parking metered within 1 km of work/study	Dummy (1=$1.25-$5.00/hour)	-0.2258 (-1.9)		-0.7495 (-4.7)†
	$2.50 or $5.00/hr		-0.0560 (-4.8)	
Registration surcharge per km	10¢ or 30¢		-0.0110 (-2.6)	
	Dummy (1=10¢ or 30¢)	-0.4907 (-4.2)		
	Dummy (1=10¢)			-0.639 (-2.8)
	Dummy (1=30¢)			-1.1664 (-4.8)
Cordon toll cost - if crossed into toll area before 10 a.m.	$5 or $10	-0.1261 (-7.4)		
	Dummy (1=$5)		-0.9631 (-6.8)	
	Dummy (1=$10)		-1.2762 (-9.0)	
	Dummy (1=$2.50 or $5)			-1.3924 (-6.3)

Drove company vehicle	1.0975 (4.6)	1.4988 (6.2)	1.2971 (2.5)
Drove other family/household vehicle		-.6742 (-2.7)	
Used car for work that day	0.7764 (4.9)	0.9083 (6.0)	1.3809 (4.7)
Parking costs in last week (log[$+1])	-0.1858 (-3.5)		
Mainly park on street – free and no time limit	-0.5995 (-4.0)	-0.3848 (-2.9)	
Mainly park on street – paid		-0.5904(-2.6)	
Mainly park off-street			1.2445 (5.7)
Mainly parked elsewhere	1.0381 (2.6)		
Roundtrip distance in km (≤10.5 km)			0.2599 (4.9)
Roundtrip distance in km above 10.5 km			0.0032 (0.3)
Roundtrip distance in km (<20.5 km)	0.0462 (4.6)		
Trips before work, not children to school	0.7894 (4.3)		
Are trips discretionary?		1.3348 (4.2)	
Full or part-time student	-0.8883 (-3.6)		
High school children in household	-0.6118 (-4.2)		
Single adult with children under 18	1.0592 (3.6)		-1.0228 (-2.9)
Group of adults living together	0.9102 (2.5)		
Single member household	-0.9389 (-3.2)		1.1372 (3.3)
Extended family, children under 18			-1.9845 (-3.7)
Couple (de facto/married)		0.5226 (3.6)	
Age 30-49			1.3573 (6.1)
Age 40-49		0.5509 (4.3)	
Passenger (in a car/private or company vehicle)			
Constant	-3.5243 (-11.7)	-4.2999 (-18.9)	-1.336 (-1.9)
Are trips discretionary?		2.5660 (6.7)‡	
Male	-2.2173 (-7.8)♪		-2.656 (-2.9)
Car pool/ride share			
Constant	-3.0517 (-9.2)	-5.1694 (-16.9)	-3.2542 (-2.7)
Bus and HOV time 35% better	0.2871 (2.4)♦		
Roundtrip distance in (Dummy 1=<20.5 km)	-1.3831 (-3.5)		
Male	-2.2173 (-7.8) ♪		
Walk and catch PT			
Constant	-2.2703 (-8.7)	-2.2307 (-10.9)	-3.9645 (-4.4)
Bus and HOV time 35% better	0.2871 (2.4)♦		0.5748 (2.6)
PT service operates within 400 meters of home/work place	0.274 (2.2)		
PT frequency in peak increased (Dummy, 1=50% or 100%)		0.3410 (2.9)□	
Are trips discretionary?	-0.8237 (-3.0)		0.9544 (2.2)
Made trips before work, not children to school			0.6114 (1.7)
Drove child to school			-1.4399 (-3.8)
Parking costs in past week (log[$+ 1])		0.3801 (8.5)♣	
Drove company vehicle			-6.9338 (-3.0)
Self-employed	-0.5884 (-2.6)	-0.7817 (-4.166)	-2.5688 (-4.3)☺
Full or part-time student	0.5121 (2.1)	0.6784 (2.5)♥	
Part-time employed			-0.9542 (-2.9)
Income total for household (CHCH only; log)			0.541 (3.3)
Age 15-39			1.9549 (5.2)
Age 20-29		0.7248 (5.1)	
Age 40-49			3.2257 (7.0)

Group of adults living together	1.8765 (5.1)		
Single member household	0.9671 (3.3)		
Primary school children in household		-0.4910 (-3.1)	
High school children, not primary, in household		-0.8637 (-3.6)	
Drive, park and ride PT			
Constant	-3.3942 (-11.4)	-3.764 (-16.7)	-1.96 (-2.1)
PT frequency in peak increased (Dummy, 1=50% or 100%)		0.3410 (2.9)□	
PT service operates within 400 meters of home/work place		-0.5109 (-2.4)	
Parking costs in last week (log[$+1])		0.3801 (8.5)♣	
Full or part-time student		0.6784 (2.5)♥	
Drove child to school		1.0415 (5.3)	
Male	-2.2173 (-7.8) ♪		-2.656 (-2.9)
Bicycle			
Constant	-4.3204 (-14.4)	-6.4912 (-12.3)	-5.642 (-4.4)
Self-employed			-2.5688 (-4.3) ☺
Roundtrip distance in km (≤10.5 km)			-0.0847 (-0.8)
Roundtrip distance in km (above 10.5)			-0.2498 (-3.1)
Own cycle in good working order (CHCH only)			4.8592 (6.2)
Male			1.6367 (3.5)
All other			
Constant	-3.4901 (-12.9)	-4.4123 (-19.0)	-1.4396 (-2.2)
Are trips discretionary?		2.5660 (6.7)‡	
Inclusive values for nested logit			
Drive, Walk and catch PT, Bicycle	-	-	0.5111 (8.2)
Other 4 alternatives	-	-	0.8953 (2.7)
Model Fit Indicators			
Log-likelihood at zero (MNL)	-4317.97	-4074.74	-4413.32
Log-likelihood constants only (MNL)	-2088.25	-2134.40	-2315.03
Log-likelihood at convergence (MNL)	-1789.68	-1768.38	-1929.116
Adjusted Pseudo-R^2 (MNL)	0.141	0.170	0.164
Log-likelihood at convergence (nested)	-	-	-1917.38
Adjusted Pseudo-R^2 (nested)	-	-	0.170
Sample Size	2219	2094	2268

Note: some variables have shared parameters (marked [s] ♦ ‡ ☺ etc) resulting from the quality constraints– the shared value has been in entered in both or all 3 of the cells. A more detailed description of each variable is available from www.pinnacleresearch.co.nz.

Where a respondent was already paying for parking, whether on- or off-street, they were more likely to choose not to Drive (Auckland) or to choose walkPT (Wellington). In Auckland and Wellington, car drivers who parked for free on the street (15.2% and 22.6% respectively) were more likely to choose not to Drive when faced with increased car costs.

Employment status also influences mode choice. In contrast with full-time employees, in Auckland and Wellington, students were less likely to continue to drive when car-operating costs were increased, choosing to use passenger transport instead. Self-employed people were less likely than full-time employees to choose to use passenger transport in all three cities, or to cycle in Christchurch. Part-time employees were also less likely than full-time to choose passenger transport in Christchurch.

Household composition, in particular whether or not there are children under 18 living in the residence, affects mode choice. It greatly reduces the likelihood of choosing walkPT, which is variously expressed in the three models as "drove child to school", making trips before work (but not driving a child to school), household structure that excludes children, and/or the presence of children in the household. In Wellington, where drivePT is a viable option, car drivers who drove children to school were far more likely to choose this alternative when faced with increased car operating costs.

Thus, the converse is true, particularly in Auckland: adults living independently (either in a single member household, or as a group of non-related adults) without children are more likely to switch to using passenger transport. There is one exception, in Christchurch, where single member households were more likely to choose Drive, and the presence of children under 18 (in households with single adults) was associated with a propensity to switch modes.

Age was not an overly significant factor influencing mode choice, given the other variables already in these models, except perhaps to state that the tendency to keep using a car (choosing Drive) is at a maximum around the age of 40, reflecting perhaps the stage of life many people experience then, with children at home beginning to be more independent and the movement of at home parents back into the workforce.

The round-trip distance from home – work/study – home was not as significant a factor in mode choice as we had expected. Distances did not feature at all in the Wellington model, and in a limited way in both the Auckland and Christchurch models. In Auckland, Drive is more attractive for longer trips, although there is no additional effect above the distance of around 20 km. Also in Auckland, Carpooling was more strongly associated with trips of at least 20 km. Not surprisingly, Cycle is less and less attractive the longer trips become. However, up to a round-trip distance of 10 km no significant effect of distance was found. Drive is (relatively) more attractive for longer trips, but this effect plateaus at around 10 km in Christchurch (given that the declining attractiveness of Cycle above 10 km is modelled separately).

3.4 Car Driver Responsiveness to the Policy Measures

The marginal effects identify the practical consequence of each policy measure (attribute) used in the stated choice experiment and are, thus, more informative from a policy perspective than simple interpretation of the parameter estimates associated with each attribute. A marginal effect may be defined as the average change in the probability of choosing Drive resulting when a policy tool (such as $5 parking surcharge or cordon charge) is applied, compared to the status quo, where none of the policy tools is applied.

Overall, the measures designed to reduce car use (by either increasing car driving costs or reducing access to parking) have higher marginal effect values than changes in passenger transport services. The ranking of the measures varies between the three cities: for example, in Wellington the cordon charge ($5-10) and the $10 surcharge on car parking buildings or lots have the greatest effect on shifting car drivers to another mode, while in Christchurch and Auckland the registration surcharge (10-30¢/km) has the greatest potential effect.

As Table 4 shows, the size of the potential modal shift (measured as a percentage shift of car drivers to another mode) varies significantly between the cities. The greatest impact of any one measure occurs in Wellington, where approximately 11% of drivers would shift to another mode if faced with a cordon charge before 10 a.m. of $10; nearly 8% would shift if a cordon charge of $5 was in place. In Christchurch, the strongest effect (8%) came from the 30¢/km registration surcharge, while in Auckland, the registration surcharge, of either the 10¢ or 30¢/km, results in an approximately 5% modal shift from car as driver.

Table 4 Marginal Effects of Policy Tools on Mode Choice

	% Shifted from Drive	**% Shifted from Drive**	**% Shifted from Drive**
	Auckland	**Wellington**	**Christchurch**
Off-Street Parking Charges			
Surcharge $5/day in car park buildings / lots		3.5	
Surcharge $10/day in car park buildings / lots		7.5	
Surcharge $5-10/day	3.6		
Surcharge $2.50-$5.00/day			4.8
On-street Parking Restrictions / Charges			
Availability restricted to < 2 hrs (0.5 or 1.5 km)	3.6	3.3	3.5
Metered within 1 km of work/study ($2.50-$5.00/hour)	2.2		
Metered within 1 km of work/study ($1.25 - $2.50/hour)			4.8
Metered within 1 km of work/study $2.50 / hour		1.7	
Metered within 1 km of work/study $5 / hour		3.5	
Registration Surcharge per vehicle-kilometre			
10¢/km		1.3	4.0
30¢/km		4.1	8.0
10¢/km or 30¢/km	5.1		
Toll Charges before 10 a.m.			
$2.50 - $5.00			4.5
$5.00	1.8	7.9	
$10.00	4.5	11.0	
Changes in Passenger Transport Services			
Bus and HOV time 35% better	1.9		2.3
PT frequency in peak increased by 50% or 100%		3.6	
PT service operates within 400 meters of home/work place	1.6		

The difference in the impact of the toll charge and registration surcharge reflects the differing travel habits in the three centres. In Wellington and Christchurch, nearly all (98%) of the respondents lived outside of the cordon area, while in Auckland only 57% lived outside the cordon. (In Auckland, the cordon area of interest to the local council was much broader than the CBD focus of the cordon areas in Wellington and Christchurch.) Approximately one-half of Auckland and Christchurch drivers had not entered the cordon area in the previous week, while 67% of the Wellington drivers had crossed into the cordon area before 10 a.m. in the previous week. Thus, the higher marginal effect for toll charges in Wellington reflects the fact that drivers in Wellington are far more likely to be affected by a cordon charge than either Christchurch or Auckland.

Similarly, differences in parking situations (see Table 5) mean that Wellingtonians would be more affected by proposals to introduce a parking surcharge or tax in car park buildings or lots. Forty-two percent of Wellington drivers reported having to pay for parking in the previous week, very different to Auckland (19%) and Christchurch (27%). In addition, only 5-6% of Auckland and Christchurch drivers reported paying more than $10 for parking in the previous week, whereas 17% of Wellington drivers did.

Table 5 Usual Parking Place while at Work or Study
Q12. In the last month, where did you mainly park your vehicle there?

		Total	Auckland	Wellington	Christchurch
	Unweighted Count	*N=732*	*N=247*	*N=233*	*N=252*
Usual parking place at work or study	off-street - resident or business	9.6%	10.5%	9.9%	8.3%
	car park provided by employer or place of study	55.1%	63.2%	47.2%	54.4%
	paid - public car park building / lot	7.7%	7.3%	11.6%	4.4%
	paid on-street parking	2.3%	.8%	5.6%	.8%
	free on-street parking	22.8%	15.4%	22.7%	30.2%
	other	2.6%	2.8%	3.0%	2.0%
Total		100.0%	100.0%	100.0%	100.0%

Increasing the metered parking costs to $2.50 per hour within one kilometre of the work or study place resulted in a smaller modal shift in Wellington (1.7%) and Auckland (2.2%) than in Christchurch (4.8%). The doubling of the size of the marginal effect could be explained by the fact, shown in Table 5, that twice as many people in Christchurch parked on-street for no charge (30%) than do in Auckland (15%). In Wellington, approximately 23% of respondents parked on-street for free.

4. Conclusions

The variation in the effects of the policy tools on car driver behaviour across the three main urban centres means that there is no single policy mechanism that will address congestion issues across urban centres in New Zealand. Government policy proposals will have to be developed in "packages", such that implementers can choose the tools appropriate to the constraints their car driving population faces.

Unfortunately, our stated preference experimental design did not permit us to assess the possible impacts of combinations of specific policy tools – this is an area for further research effort.

The more "severe" measures designed to affect the choice to drive a car have a much greater influence on mode choice than do measures to improve passenger transport services or increase the availability of cycle lanes. However, this is not to say that policy makers should ignore the need to improve passenger transport services, as people encouraged to switch modes need an alternative that is convenient to use. Our results show that implementing measures to promote the use of alternative modes, such as passenger transport and cycling, without complementary measures to deter car use is not going to have the desired effect on traffic growth and congestion. This confirms the previous European finding by Marshall and Banister (2000). Anecdotal evidence from Auckland, indicates that while there has been significant increases in passenger transport usage have been recorded over the past 3 years (approximately 7% per year) due to improvements in trip times and trip frequency, little or no impact has been made on traffic growth in the region.

Although measures to increase the cost or inconvenience of driving a car show the greatest potential in addressing congestion issues, our study reveals a number of decision-making constraints that pre-empt drivers from choosing an alternative mode of travel to their work or place of study. In particular, employment practices (such as company-owned vehicles, providing on-site parking, and using the car for work-related trips during the business day) significantly constrain the ability of employees to choose not to drive a car. Likewise, self-employed people were more likely to continue to choose to drive. This result suggests that further investigation into the linkages between employment policies and practices and their influence on mode choice is warranted. A better understanding of these linkages will enable policy-makers, employers and employees to better determine the types of policy actions that would generate significant changes in mode usage.

Drivers living in households with children generally felt more constrained to choose to drive than did households comprised of adults only. However, we know that this type of constraint can be reduced by initiatives such as the “walking school bus,” which sees the burden of transporting children to and from school shared with other parents (O’Fallon et al., forthcoming). Students also had more flexibility about the mode they used. Surprisingly, perhaps, we found that age and distance travelled did not impose strong constraints on mode choice decisions.

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