Estimation of Public Transport Fare Elasticities in the Sydney Region

INDEPENDENT PRICING AND REGULATORY TRIBUNAL
OF NEW SOUTH WALES

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Research Paper No 7

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This is a non-technical version of a consultancy report prepared by Professor David Hensher and Mr Timothy Raimond of the Institute of Transport Studies. The original report is detailed and statistical in nature. This version has been prepared by the Tribunal's staff to communicate the findings of the work in a way which can be easily understood by the wider community.

Copies of the original consultancy report can be purchased from the Tribunal office.

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Foreword

The Independent Pricing and Regulatory Tribunal of NSW is undertaking a review'of the pricing policies for urban public passenger transport. A review of pricing principles cannot be considered in isolation of the effect changes in prices would have on patronage of public transport.

The Tribunal commissioned the Institute of Transport Studies (ITS) to conduct a survey within the Sydney region to estimate the sensitivity of travel choice to fare changes. This sensitivity is referred to as fare elasticity. As part of the project, ITS developed a computer model which allows the implications of various fares policies for the social and environmental benefits of public transport to be assessed. Of course, the social and environmental benefits of public transport depend on how much it is used, ie the number of journeys taken.

This non-technical paper has been prepared by the Secretariat of the Tribunal to communicate the findings of the work in a way which can be easily understood- by the wider community.

The results tend to confirm that travel decisions do not vary greatly if fares change. The computer spreadsheet model combines the elasticity information with information about the transport network top examine the consequences of alternative fares policies. The implications of alternative public transport policies for road congestion (which has important environmental aspects) are also derived. The model will help the Tribunal to evaluate various fares policies.

Thomas G Parry
Chairman

October 1996

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EXECUTIVE SUMMARY

Consumers' reaction to fare increases will affect whether revenue will increase or decrease. If a small increase in the fare causes many consumers to no longer use a service, the overall result may be a decline in revenue from that service.

This report discusses a project undertaken by the Institute of Transport Studies (ITS) for the Independent Pricing and Regulatory Tribunal of NSW (IPART). ITS conducted a study to determine how much the travel decisions of Sydney residents change in response to changes in public transport fares.

For Part A of the three part study, ITS collected data which then served as input for Parts B and C. Part B involved doing a survey using a questionnaire designed to collect data on the sensitivities of travel decisions to changes in fares. Part C used the data collected in Part A and the findings of the survey to construct a Decision Support System (DSS) for IPART. The DSS evaluates the impact of fare changes on travel decisions, costs and operators' revenues, as well as the extent to which passengers are made better off or worse off. This report discusses the findings,

The aim of the survey was to obtain information on travellers' sensitivity to fare changes on each of the main modes of passenger transport in urban NSW: train, bus and ferry. The survey collected information and calculated sensitivities for fare changes in the mode normally used, as well as for alternative modes. These fare sensitivities were fed into a DSS to identify the impact of a range of pricing options on congestion, user benefits and operators' revenue streams.

The analysis combines data on revealed preference (demonstrated by behaviour) and stated preference (what respondents state they would do in various situations). This is the first time that data has been combined in this way in an Australian study. It will permit more accurate estimation of sensitivities than has been possible previously.

The results are very informative. They tend to confirm that travel decisions do not vary greatly if fares change. As might be expected, commuters are generally less sensitive to fare changes than are non-commuters for the equivalent ticket type and mode. Sensitivity within a market increases from a single ticket through to multiple-trip tickets. The implication is that an increase in a multiple trip fare purchase is regarded as substantial in absolute dollars, in contrast to an increase in a single fare, despite the convenience of purchasing a multiple trip ticket. This has interesting implications for a fares policy ie increasing the price of a single ticket offers higher revenue growth prospects with smaller losses of patronage than is the case for weekly tickets, travel passes, travel tens and multi-modal tickets.

1 INTRODUCTION

The Independent Pricing and Regulatory Tribunal of NSW (the Tribunal) is reviewing urban public passenger transport fares. The Tribunal is interested in the extent to which changes in fares would result in a change in travel patterns for each mode, thus affecting the social and environmental benefits associated with travel mode choices. The Tribunal specifically requires information on the way in which changes in fares would affect the use of public transport.

The Tribunal commissioned the Institute of Transport Studies (ITS) to conduct a survey within the Sydney region to estimate the sensitivity of travel choice to fare changes. This sensitivity is referred to as fare elasticity. Strictly speaking, fare elasticity measures the extent to which the number of journeys in a travel mode varies in response to a percentage change in fares. As part of the project, ITS developed a computer model which allows the implications of various fares policies on the net social benefit and externality benefits to be assessed. Of course, the social and environmental benefits of public transport depend on how much it is used, ie the number of journeys taken.

Having completed its survey and estimated the fare elasticities, ITS provided a computer model and a report to the Tribunal[1]. The report provides much detail about the methodology for calculating elasticities, which is surnmarised here.

The consultancy report provides detailed information on travellers' reactions, or sensitivity, to fare changes for each of the main modes of transport. These fare sensitivities are referred to as fare elasticities and are calculated for each public transport mode (direct elasticities) and between each public transport mode and with other public transport modes as well, eg the automobile (cross elasticities). The fare sensitivities (or elasticities) indicate the extent of switching between selected ticket types and modes of transport for any given combination of changes in fare levels. The results are presented here in a series of tables (Tables 12-16 and Table A2) which show direct and cross elasticities.

A computer spreadsheet model has been developed to evaluate the impact of changes in public transport fares on patronage and operator revenue. This model combines the elasticity information with information about the transport network. The implications of alternative public transport policies for road congestion (which has important environmental aspects) are also derived. The DSS will help the Tribunal to evaluate various fares policies.

In the past, most research used aggregated fare data. Little research has been conducted on elasticities by ticket type in Australia. ITS therefore undertook its own survey. It asked for information on:

a) the choice of mode for each specific trip

b) the choice of ticket type within each public mode.

Some trips are optional and non-commuters have different sensitivities to fares. Thus, a distinction is made between commuting and non-commuting travel.

[1] Hensher, D and Raimond, T. *Evaluation of Fare Elasticities for the Sydney Region,* March 1996. Institute of Transport Studies.

The report is organised as follows: Chapter 2 describes the role that a stated choice experiment plays in combination with revealed preference data. Chapter 3 outlines the survey design and data collection. Chapter 4 gives the empirical results of the survey and the various elasticities.

2 REVEALED PREFERENCE AND STATED PREFERENCE TECHNIQUES

2.1 A survey combining revealed and stated preference techniques

When trying to understand people's behaviour, several different types of data can be collected. One method is to watch and record the way people behave in the "real world", and infer reasons for why they did what they did. This type of data is called revealed preference (RR) data. Another method is to present people with a hypothetical situation, and ask them how they would respond in that situation. This is called stated preference (SP) data. SP techniques are used because they are like a scientific experiment — the analyst can change the price levels in each scenario and see how this affects responses.

As it is not possible to collect RP data without implementing a policy change, SP results are better suited to evaluating the effect of a planned policy change on people's behaviour before that change is implemented. SP methods ask people how they would respond in various scenarios. SP methods are most valid when the scenarios reflect reality, that is, when the scenarios relate to people's current behaviour in some way. This method combines RP and SP.

In the survey, travellers were asked to think about the last trip they had made. They were asked where they went, how they travelled and how much it cost. Then they were asked to describe another way they could have made that trip if their current mode was not available. Their current behaviour revealed their preference, providing RP data. The survey also varied public transport fares for travellers' current and alternative methods of travel under a series of different pricing scenarios. Survey respondents were asked to state what they would do in each situation. Responses to these different scenarios were recorded in terms of what mode of transport they would use and which fare they would use, providing SP data.

In the SP section of the survey, ticket prices varied from current levels to 50% above and below current levels. Each respondent was presented with four different scenarios (or showcards — see Figure 1). Different respondents were presented with different combinations of scenarios. Scenarios were developed and presented in such a way that it was possible to determine, under any fare scenario within the 50% above and below range, how many people would travel with each ticket and on each mode, and to thus derive how sensitive people are to fare changes (elasticities).

2.2 Why develop and apply stated preference experiments?

SP methods have used been most widely in transportation and marketing research. The literature on SP theory and methods is vast. It covers psychology, marketing, management and decision science, geography, sociology, economics, transportation research and planning, as well as other fields.

The main reason for using SP methods, for this study of fare elasticities, is that there are real and serious limitations to much RP data. Managers who want to forecast the likely market potential of a "new" product often find RP data inadequate to this purpose. New products or services, such as transport options like bus priority systems contain at least one new attribute not possessed by present options. The range of attributes of new services may lie far outside current experience (eg fare levels well beyond present experience, or a new fare payment method not presently available). Finally, many new products and services introduce whole new product categories such as new personal communication devices (eg mobile phones) and are not suited to RP methods.

Each of the previous examples illustrates how RP data can be inadequate for market measurement and forecasting. Additionally, the factors that explain behaviour in real markets often vary over quite limited ranges, hindering attempts to obtain accurate estimates of the effects of those factors on choice. For example, in 1977 the Bureau of Transport Economics wanted to determine the likely passenger demand consequences for Qantas if Australia renegotiated its bilateral landing-rights treaties, lowering fares on some transpacific routes into and out of Australia. At the time, fares had not changed on any routes in many years, and were the same for all competitors on particular routes. Patronage data on these routes was plentiful, but it could not be used to estimate likely consumer reactions to fare changes because:

a) the proposed changes were well beyond previous experience

b) previous choices made on particular routes could not be associated with changes in fares.

The above reasons, together with the fact that the collection of accurate and comprehensive RP data is timely and expensive, have encouraged the development of SP techniques in transportation and related fields. SP development has been further encouraged by ever increasing research focusing on how individuals and groups of individuals make decisions and choices, as opposed to research on how decisions ought to be made. Growth in Behavioural Decision Theory in psychology has inspired many other social sciences to become interested in understanding and modelling decision processes, as well as applying the models and resulting insights derived to solve practical problems in many areas. Thus, SP theory and methods are now widely applied to solve practical policy problems like those addressed in the present study.

Figure 1 Example of a bus or train showcard for a short trip

S–BT1

BUS OR TRAIN?

You have told us that you could use either a bus or a train as the main form of transport to travel to the destination that we have discussed.

- **If public transport fares changed and were priced as below, would you have used Bus or Train as the main form of transport for your trip?**

BUS FARES		TRAIN FARES	
Single	$0.60	Single	$0.80
TravelTen *(10 single trips)*	$4.00	Off Peak Return *(purchase after 9am)*	$0.90
TravelPass *(7 days bus/ferry)*	$8.60	Weekly *(7 days train only)*	$6.80
TravelPass *(7 days bus/ferry/train)*	$10.00	TravelPass *(7 days bus/ferry/train)*	$10.00

- **Which ticket type would you choose?**

3 SURVEY DESIGN AND DATA COLLECTION

The aim of the survey was to obtain a full matrix of direct and cross fare elasticities for each of the main modes of passenger transport in urban NSW.

The survey of a sample of commuters and non-commuters was confined to the Sydney Metropolitan Area. The survey had to identify both current behaviour and the potential to switch to alternative modal and ticket use behaviour under a range of alternative fares policies for the government bus, ferry and train systems. Figure 2 is a flowchart summarising the survey design and data collection process used by ITS.

3.1 Sampling strategy

To survey a sufficient number of travellers currently choosing each of the available modes (including car) and available ticket types in each of the market segments, a sample size of 614 was chosen. Half these were commuter trips and half, non-commuter trips. Inner, middle and outer areas of Sydney were sampled in roughly equal proportions, as was each mode.

The questionnaire required about 20 minutes of interview time. This meant using a face to face home interview approach. Some surveys had to be conducted on ferries in order to obtain a sufficient number of ferry users in the sample. Table 1 lists the survey start points for home interviews. This table does not include those areas which were targetted to obtain a sufficient sample of users of bus and ferry routes. The start points were generated by randomly choosing postcodes within each Statistical Local Area (local council area) in Sydney. Within each postcode, a random street was chosen and a group of dwellings was sampled. As a random sample of the population did not capture enough ferry users, permission was obtained from State Transit to survey passengers on Sydney Ferries.

To ensure that enough people who were currently choosing each of the alternative modes/ticket types was sampled, respondents were selected on the basis of mode used. This is corrected in estimation to reproduce the base market shares.

In addition, all observations are weighted to the distribution of personal income for commute and non-commute demand as revealed in the 1991 Sydney Travel Survey (see Table 8 for base market shares).

3.2 Developing the experimental design

One of the difficulties associated with using a combined RP/SP approach is the need to present individuals with a stated preference experiment in which all respondents have a realistic choice of travel options. Given that people use different modes and travel over greatly varying distances, it was necessary to develop a range of showcards with different modal combinations and different travel distances. Answers to the questionnaire told the interviewer which showcards were appropriate for which respondents.

Figure 2 Survey design and data collection process

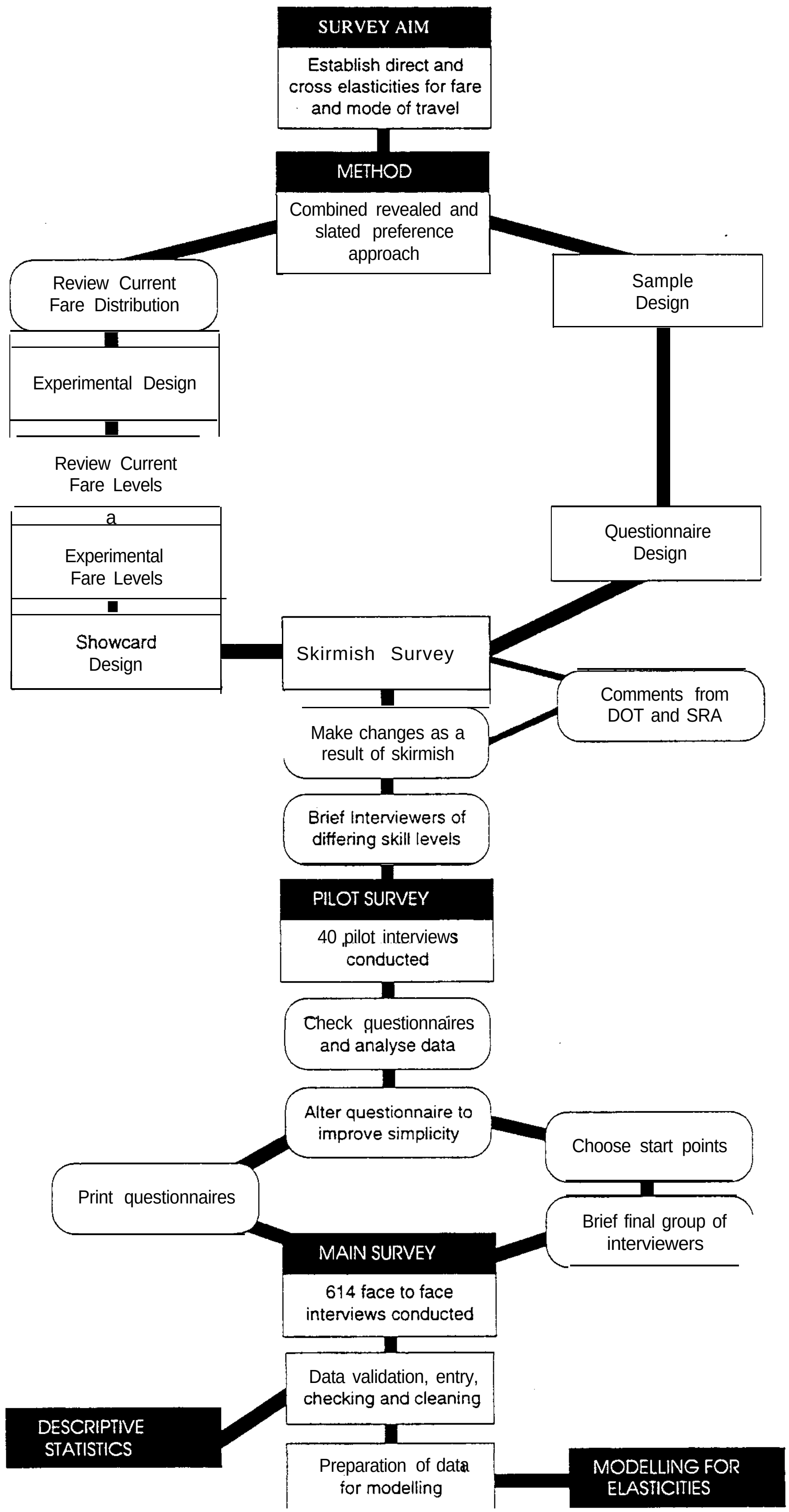


Table 1 Starting suburbs for home interviews

inner Suburbs	Middle Suburbs	Outer Suburbs .
Manly	Gladesville	Mt Pleasant
Bondi (2)	Manly (north)	Penrith (2)
Mascot	Kogarah	Quaker Hill (2)
Rose Bay	Caringbah	Kellyville
Cremorne	Sylvania	St Clair
Mosman (2)	Frenchs Forest	Seven Hills
Randwick	Lindfield	Blacktown (2)
Hunter's Hill	Auburn	Bosley Park
Ryde	Forestville	Willmot
Balmain (2)	Collaroy	Winston Hills
Dulwich Hill	Epping North	Narellan
Wollstonecraft (2)	Concord	Castle Hill (2)
Coogee	Thornleigh	Liverpool
Waverley	Summer Hill	Bidwill
Glebe	Croydon Park	Marayong
Bondi Beach	Croydon	Airds
Five Dock (2)	Belfield	Baulkham Hills
North Sydney	St Ives (2)	Penrith South
Paddington	Hurstville	Blacktown
	Rivet-wood	Campbelltown
	Carlingford	Macquarie Fields
	Tempe	Leonai
	Roselands	
	Pymble	
	Queenscliff	
	Earlwood	
	Villawood	
	Hillsdale	
	Westmead	

The showcards developed for this study cover every combination of main mode (car, train, bus and ferry) and have levels for short trips (under 15 minutes), medium trips (15-30 minutes) and long trips (over 30 minutes). These times refer to the length of time spent in the main mode only, not the access, egress or waiting times.

In order to keep the experiment and sample size to a manageable size, it was necessary to consider only the most frequently used public transport ticket categories. Table 2 shows the distribution of ticket sales in 1991.

Table 2 Profile of public transport users by ticket type

Ticket Type	Commuter	Commuter %	Non-Commuter	Non-commuter %
Metroten — blue	12,137	4.2	26,409	3.3
Metroten — green	2.801	1.0	1,507	0.2
Metroten — orange	226	0.1	459	0.1
Metroten — red	17,426	6.0	21,937	2.9
Other	4,207	1.5	206,087	25.9
Quarterly — not travel pass	4,444	1.5	4,257	0.5
Return ticket	31,832	11.0	196,543	24.7
Single ticket	41,969	14.4	182,103	22.9
TravelPass — blue	10,282	3.5	19,486	2.4
TravelPass — brown	679	0.2	339	0.1
TravelPass — green	6,958	2.4	8,374	1.0
TravelPass — orange	683	0.2	2,584	0.3
TravelPass — pink	2,920	1.0	3,272	0.4
TravelPass — purple	482	0.2	156	0.0
TravelPass — red	20,159	6.9	21,427	2.7
TravelPass — two zone	595	0.2		0.0
TravelPass -yellow	555	0.2	1,777	0.2
Weekly — not travel pass	119,632	41.2	85,635	10.7
Yearly — not travel pass	12416	4.3	14,322	1.8
Total	290,503	100.0	796,674	100.0

Source: 1991 Sydney Travel Survey

Note: Data is based on home-to-work and work-to-home trips for an average weekday and includes Sydney Region residents only - that is, excludes Central Coast and the Blue Mountains.

An interesting aspect of Table 2 is the large number of non-commuter trips in comparison to commuter trips. Part of the problem lies in the definition of a commuter trip. Commuter trips are only those directly to or from work, excluding any intermediate trips or trips from work to somewhere other than home.

Using the distribution in Table 2, an experimental design was developed which gave each respondent 15 trip alternatives that are hypothetically possible. These alternatives were based on one car alternative, four train tickets, four bus tickets, four ferry tickets and two jetcat tickets — a total of 15 alternatives.

The result of this choice experimental design is a set of 90 showcards (ie 15 alternatives with six showcards for each alternative). The need to present all respondents with realistic scenarios by having fares for three lengths of travel, means that there are 270 showcards in total, 90 for each trip length (short, medium and long).

For this reason, it was not possible to include those people entitled to concession fares since they would have required whole new sets of showcards to present them with realistic fares. This would have resulted in about 800 showcards, which is not manageable for interviewers. Table 3 indicates that by not sampling those entitled to some sort of concession fare, 8% of the commuter market was eliminated along with 62% of the non-cornmuter market.

Table 3 Profile of public transport users by fare type

Fare Type	Commuter	Commuter %	Non-commuter	Non-commuter %
Discount	1,329	0.4	3914	0.4
Full	262,895	92.4	371,816	38.0
No fare required	7,176	2.3	105,290	10.8
Other	0	0.0	10,392	1.1
Other concession	5,481	1.8	66,773	6.8
Pensioner concession	4,250	1.4	134,935	13.8
Student concession	4,274	1.4	97,936	10.0
Student pass	0	0.0	181,183	18.5
Group/family concession	0	0.0	2,978	0.3
Unknown	725	0.2	2273	0.2
Total	**306,130**	**100.0**	**977,490**	**100.0**

Source: · 1991 Sydney Travel Survey

3.3 Explanation of the fares in the showcards

Fare elasticities are valid only within the bounds of the minimum and maximum fares presented in a Stated Preference experiment. The Tribunal wanted the elasticities to be applicable to a wide range of fares, and thus decided that a 50% variation around current fare levels was appropriate for the experiment.

The experimental design was limited to three ticket types for train, and four ticket types each for bus and ferry. In order to provide realistic fare scenarios to respondents, ITS developed three different scenarios based on travel time in the main mode of travel. The travel time options were the short trip (of under 15 minutes in the main mode), the medium length trip (of 15-30 minutes in the main mode), and the long trip (of over 30 minutes in the main mode).

The need to base fares on current reality is complicated by the fare structures of the different modes. The public transport modes have a distance rather than time-based fare structure, and distances have been aggregated in different ways by the different agencies. For example, Sydney Buses has a very large (proportionally) range for its 3-9 section ticket — the lower end of the range should be a short trip, while the middle and higher end should be medium. This makes it difficult to present realistic scenarios to all respondents, but given the large range in the levels of fares presented to respondents (50% above and below current levels), this problem is minor.

The fares shown in this section are the base fares for the experiments. The fares on the showcards range from these fares to 50% below and 50% above these fares.

3.3.1 Train fares

Major suburban centres served by rail, such as Homsby, Parramatta, Bankstown and Sutherland are all 20-25 kilometres from the Sydney CBD, and are considered to lie at the boundary between a medium and a long trip. Thus, all trips of greater length than 26.53kms (a CityRail ticket price boundary) are considered long trips for the sake of the scenarios presented (up to 55.5km, but we assume only a very small number of trips occur beyond that distance). All trips under 13.66kms are regarded as short trips, which leaves all those between 13.66 and 26.53km as medium trips. The fares to be used as the current base are averages of current fares across the range of distance bands, intended to present the most realistic scenario.

Unfortunately, TravelPass does not match these distances perfectly (for example, the whole Bankstown line has a maximum fare of a Green TravelPass, which is equivalent to paying for no more than 13.66kms, even though Bankstown is 19km from Central). Thus, Red TravelPass is considered a short trip, a Green and Yellow TravelPass is a medium length trip, and Pink, Brown and Purple TravelPasses signify a long trip.

As return tickets are twice the price of single tickets, respondents who would normally purchase a return ticket are treated as single ticket purchasers. However, respondents who began their trip after 9am were given the option to choose an off-peak return instead of a single. This exemplifies CityRail's offering an off-peak return fare which is not double the single fare.

All fares over $20 for all modes have been rounded to the nearest dollar, as is con-u-non practice for the transport agencies.

Table 4 Base train fares by trip length

Trip Length	Single (Off Peak Return)	Weekly	TravelPass
Short	$1.60 ($1.75)	$11.50	$20.00
Medium	$2.60 ($2.80)	$19.40	$28.00
Long	$3.60 ($4.00)	$26.00	$39.00

3.3.2 Bus fares

The inflexibility in the STA fare structure makes it difficult to differentiate short and medium trips. The best option is to regard Sections 1-2 tickets as short trips, 3-9 as medium and 10-27 as long trips. Sections are approximately equal to a mile (1.6 km) in length. For TravelPass (Bus/Ferry), the Blue ticket is the basis for the short fare, the Orange ticket for the medium fare, and the Pittwater ticket for the long fare. For TravelPass (Bus/Ferry/Train) the same classification as used for the train has been adopted (Red is short, Green and Yellow are medium, and Pink, Brown and Purple are long).

Table 5 Base bus fares by trip length

Trip Length	Single	TravelTen	TravelPass (Bus/Ferry)	TravelPass (Bus/Ferry/Train)
Short	$1.20	$8.00	$17.10	$20.00
Medium	$2.50	$16.00	$23.00	$28.00
Long	$3.90	$32.00	$34.00	$39.00

3.3.3 Ferry fares

Short ferry trips are defined as Inner Harbour Services. Medium trips are those to Manly or Rydalmere, and long trips are those to Parramatta. The classification of TravelPasses for train and bus is also used for ferry. For medium length trips, people who catch the Jetcat to/from Manly are also given a realistic fare.

Table 6 Base ferry fares by trip length

Trip Length	Single	FerryTen	TravelPass (Bus/Ferry)	TravelPass (Bus/Ferry/Train)
Short	$2.80	$16.40	$17.10	$20.00
Medium	$3.60	$25.00	$23.00	$28.00
	(Jetcat=$4.80)	(Jetcat=$40.00)		
Long	$4.20	$29.00	$34.00	$39.00

Appendix 2 gives the full range of fares used in the experiments.

3.4 Pilot survey

In order to test the questionnaire and the data collection process, a pilot survey of 40 respondents was conducted in September 1995. The questionnaire flowed well, and the interviewers believed that, owing to the interesting nature of the questionnaire, respondents genuinely enjoyed answering the questions.

The pilot questionnaires were checked for accuracy and analysed. Some problems with interviewer interpretation were discovered, and the interviewers had some suggestions for improving the simplicity of the questionnaire.

3.5 Conduct of the main survey

A final interviewer briefing was given with help from pilot interviewers in order to maximise understanding of the survey instrument and its purpose. The start points for each of the interviewers were then generated. The field work began on 18 October 1995 and was completed by 15 December 1995. Starting suburbs are listed in Table 1. The following is an extract from the fieldwork report for the main survey:

Sample fieldwork report

Method	**Door to Door**
Interviewers	11
Supervisors	1
Interviews achieved	649
Average interview length	17 minutes
Achievement rate per hour	1.1
Timing	
18 October 1995	Interviewer briefing
19 Oct - 24 Nov 1995	Door to Door fieldwork
25 Nov - 15 Dec 1995	Fieldwork carried out by trip location and aboard ferries to achieve choice-based sample sizes

Validations

10% minimum of each interviewer's work was validated by telephone call back using the following questions:

Q1: **Do** you hold a concession pass when travelling on public transport?
Q3: **How** do you usually travel to work?
Q62: **Do** you have a current driver's licence?
Q69: Which of these categories best describes your age last birthday?

4 EMPIRICAL RESULTS

4.1 Response rates

Table 7 provides a detailed breakdown of response rates to the main survey.

Table 7 Response rates

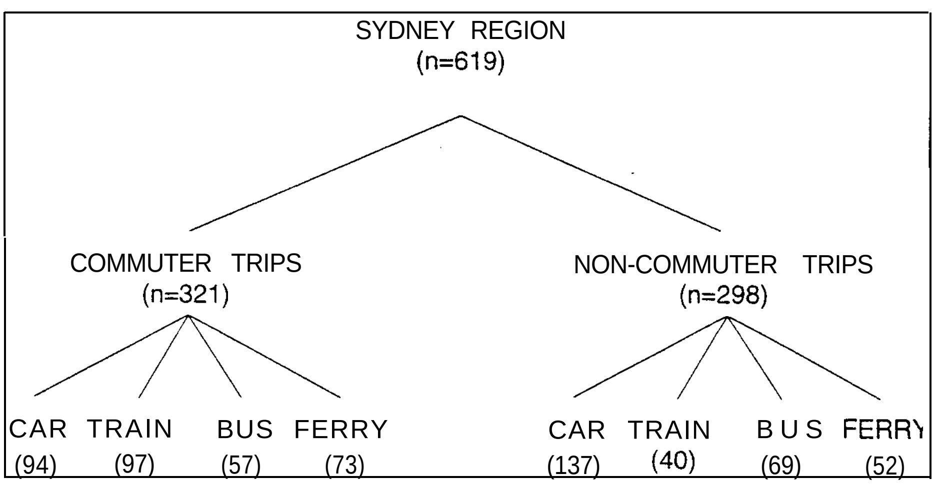
Response	Number	Percentage
Not at home	3981	47
Refusals	1116	13
Call backs	57	2
Other	94	2
Non quota	2375	28
Interviews	649	8

This table indicates that it was quite difficult to find respondents, particularly those in the quota targets. The effective response rate from those who were in the quota and were at home was 37%, which is about average for surveys of equivalent length. There was a high percentage of "non quota" respondents, partly because those entitled to a concession fare were not part of the sampling frame.

4.2 Description of sample

While the full sample collected was 649 cases, not all cases had sufficient data to be suitable for modelling. Figure 3 gives the breakdown of useable responses by trip purpose and mode.

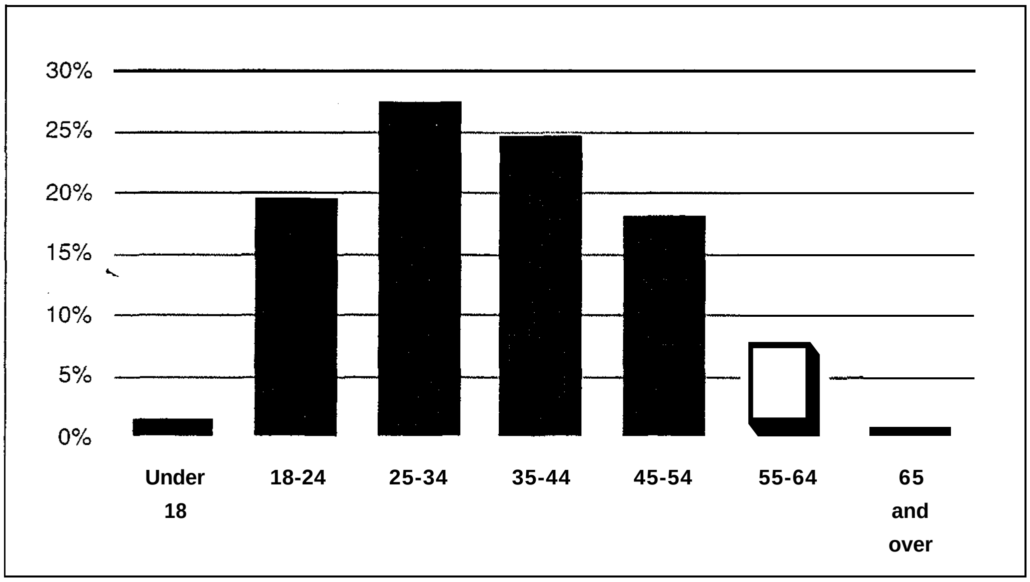
Figure 3 Breakdown of fully completed interviews



As this survey involved choice-based -sampling, the sample is not' representative of the population. External data was used to make the data representative of the population.

Figures 4 to 6 show some of the socio-demographic features of the sample.

. Figure 4 Age distribution of sample

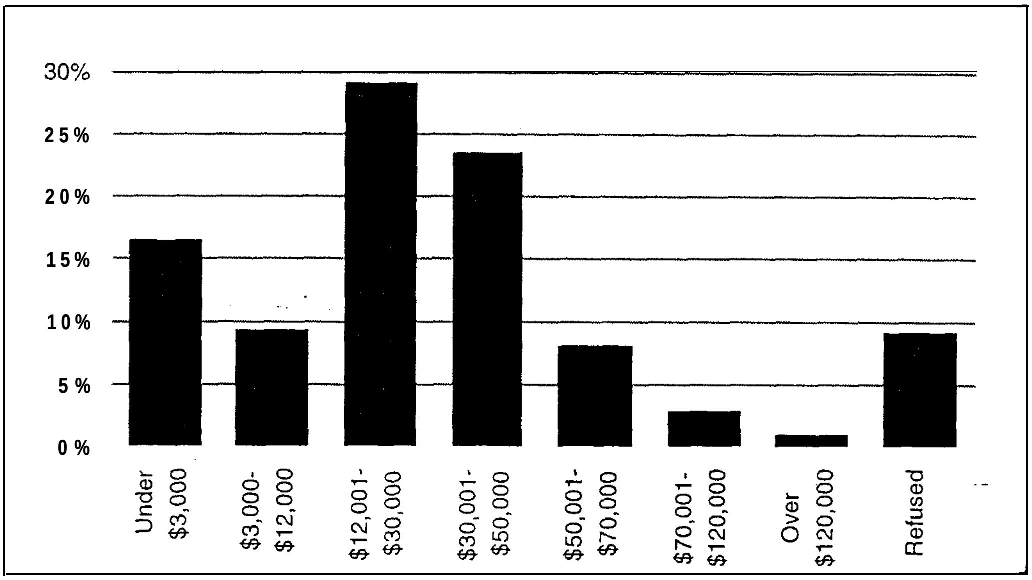


Sampling within households was random - the person whose birthday it was next **was** asked to fill in the questionnaire. However, the sample appears to be biased towards those in their twenties and thirties. The elderly, in particular, are under-represented because concession travellers were excluded from the survey. Elderly people are most dependent on public transport because the car is often not an option for them. There are also very few respondents under 18 years, although respondents 16 and over were eligible. This group is also dependent on public transport.

The sample also over-represents female travel behaviour. Approximately 60% of respondents were female.

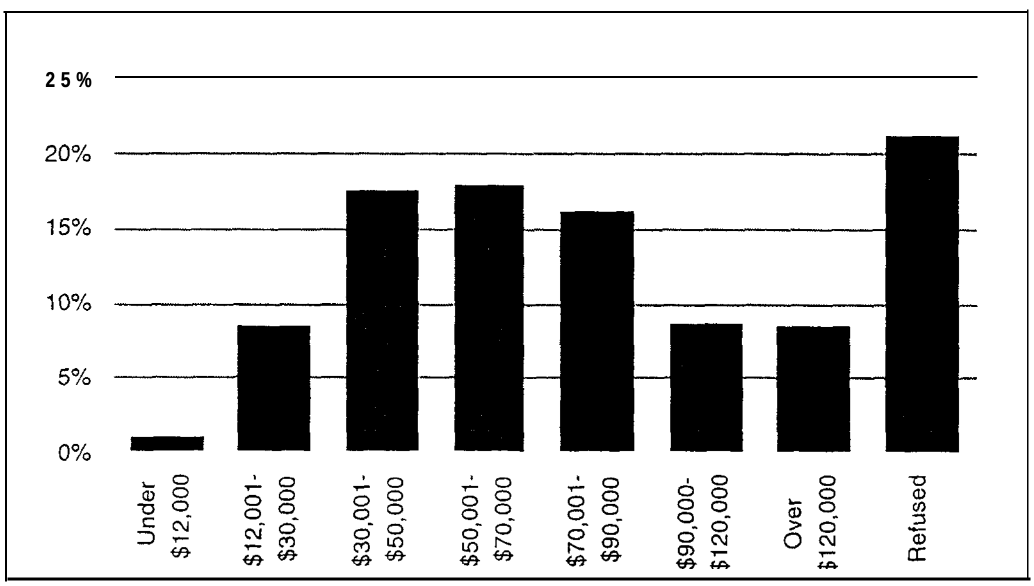
Nine % of respondents refused to state their personal income, but of those that did, there appears to be a good spread of respondents from those not earning an income -to those in very high income categories. When it comes to wealth and the mobility it generates, household income is actually a better indicator of mode choice.

Figure 5 Gross personal income distribution of sample



The refusal level was higher for household income than for personal income (this question followed personal income, and thus a higher refusal rate must be expected). Showing those who did report their household income, Figure 6 indicates that the sample covered the full spectrum of wealth in the community.

Figure 6 Gross household income distribution of sample



While 88% of the sample had a current driver's licence, only **9.4%** of respondents reported no household vehicles. Whereas the lowest level of car ownership was amongst bus travellers, car (naturally) and ferry travellers had the highest levels. Thus, it seems that the sample is a fairly broad representation of the population, though males and the elderly are slightly under-represented.

4.3 Travel behaviour and choices of sample

The surveys also provide information on average fares, travel times and trip rates for each type of ticket by trip purpose. This data is central to the operation of the Decision Support System (DSS). Table 8 shows the base data (excluding elasticities) which was input into the DSS. [2]

Commute trips are defined as trips from home to work and work to home. All other trips are non-commute trips. Table 8 shows how important non-commute trips are in total travel.

The averages presented in Table 8 are based on the sample surveyed for this project. In some cases there were not enough respondents in each cell to provide a realistic estimate (eg TravelPasses are not popular among non-commuters). In these cases, an educated adjustment was made to the average estimate. The data in the DSS can be changed when better estimates are available (eg with new TDC data from 1996 onwards).

Table 8 Base data inputs for decision support system

Ticket type	Daily Commute Trips	Daily Non-Commute Trips	Average Commute Time	Average Non-Commute Time	Average Commute Fare (one-way trip)	Average Non-Commute Fare (one-way trip)	Average Commute Trips per Ticket	Average Non-Commute Trips per Ticket
Train Single	42,786	100,499	33	33	$2.85	$2.83	1	1
Train Off Peak Return	3.220	78,964	25	25	$1.55	51.55	2	2
Train Weekly/Periodical	127.890	89,289	50	50	$2.50	$2.50	9.2	9.2
Train TravelPass (BFT)	21,805	18.659	63	63	$2.40	$2.38	10	10
Bus Single	53,456	41,836	23	25	$1.55	$1.84	1	1
Bus TravelTen/Periodical	88,552	41,024	26	24	$1.00	$1.14	10	10
Bus TravelPass (BF)	40,732	18,103	48	26	$0.94	$2.26	15.7	15.7
Bus TravelPass (BFT)	48,999	21,777	30	29	$0.91	$2.15	10.5	10.5
Ferry Single	5,348	8.728	40	40	$2.91	$3.23	1	1
Jetcat Single	1,322	1.874	15	15	$4.80	$4.60	1	1
Ferry TravelTen/Periodical	4,738	1,168	34	34	$1.75	$1.54	10	10
Jetcat TravelTen	896	232	24	24	$3.95	$3.89	10	10
Ferry TravelPass (BF)	4,230	1,327	31	31	$1.40	$2.21	1.5	1.5
Ferry TravelPass (BFT)	2,658	1,337	31	31	$1.45	$2.74	0.6	0.6
Car	821.344	5.619.476	23	23	$1.35	$1.35	1	1
TOTAUAVERAGE	*1,267,976*	*6,044,293*	*33*	*32*	*$2.08*	*$2.38*		

Average commuter trips per ticket are based on the survey except where the ticket determines the number of trips (eg single, return, TravelTen)

Table 8 shows that people generally travel longer by train than by bus or ferry. Car trips are generally the shortest in terms of time spent travelling. They are also the cheapest, assuming operating costs of 9¢ a kilometre. Across all modes and ticket classes, individuals typically pay $2 to $3 per one way trip. Usually non-commuters pay more on public transport because they cannot take advantage of the periodical fares that cornmuters use. Car travellers have less expensive non-commuting trips, perhaps the result of a combination of shorter distances and travel outside peak travel times.

2 The 1991 Sydney Travel Survey is the source of the daily number of trips by ticket type. This is the most current data available for all modes in Sydney, though the Department of Transport's Transport Data Centre (TDC) will be starting a continuous survey program in 1996 to collect up-to-date data.

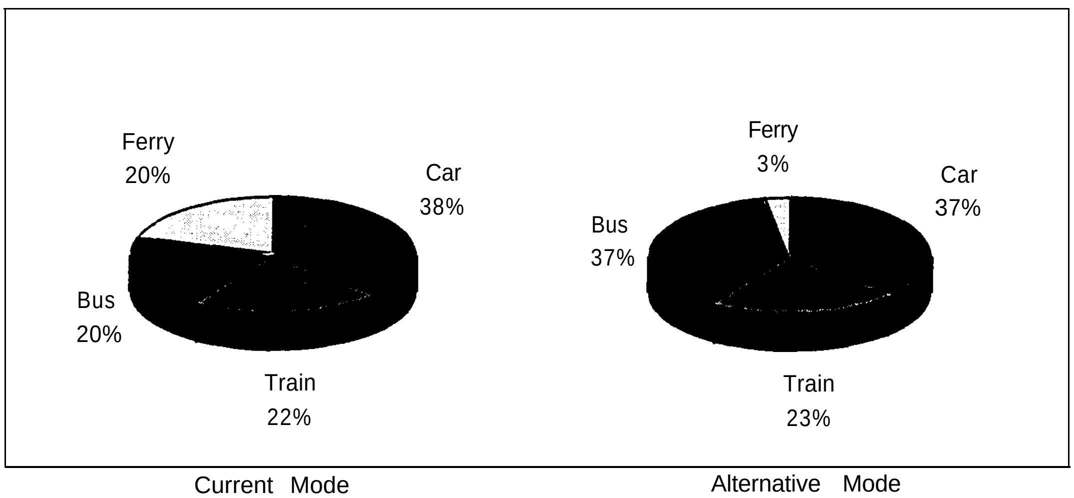
One of the most interesting findings shown in Table 8 relates to the average number of trips a week that travellers make by different ticket types. The train periodicals are used about 10 times a week on average by commuters. Historically, public transport providers have assumed 11 trips per weekly ticket, but with the advent of flexidays and rostered days off, they appear to be used 10 or fewer times per week. Commuters on bus and ferry generally use periodicals between 7 and 10 times a week. The frequency with which non-commuters buy non-periodical tickets (which are not discounted) coupled with the infrequency of use when they do purchase periodicals helps explain why non-commuters pay more than commuters pay per trip on average.

Because respondents use multi-trip tickets for both commuting and non-commuting trips, the average trip rates per week used in the DSS differ slightly from those shown in the survey.

4.3.1 Mode choice

Figure 7 shows the current mode and alternative modes respondents would choose.

Figure 7 Current and alternative modes chosen by sample



The current mode is influenced by the sampling (car was over sampled), but it can be seen that the car is a popular alternative if the public transport mode is not available. The bus is also a very popular alternative mode. This may indicate that people in areas with access to a bus service usually still choose to use the car, but in areas where people have access to a train, they are more likely to use the tram if they can.

Table 9 helps confirm this idea, showing the percentage of respondents who chose each modal combination of current and alternative modes. The largest group is that of car users who have bus as an alternative (29%). The next largest is train users who use car as an alternative. Eight % of respondents claimed to be captive to public transport (that is, they had no realistic alternative to using public transport). The majority of these, 60% were current bus users.

Table 9 Modal pairs chosen as current and alternative modes

	Alternative Mode				
Current Mode	*Car*	*Train*	BUS	*Ferry*	*Total*
Car	0%	12%	24%	0%	37%
Train	16%	0%	5%	1%	22%
Bus	15%	4%	0%	2%	20%
Ferry	5%	7%	8%	0%	20%
Total	*37%*	*23%*	*38%*	*3%*	*100%*

Under the SP approach, respondents had to choose between their current and alternative modes for a range of different fare scenarios. Table 10 shows choices made by respondents in the stated preference experiment, broken down by their current mode.

Table 10 Current mode and mode chosen in SP experiment

	Chosen Mode (SP)				
Current Mode	*Car*	*Train*	*Bus*	*Ferry*	***Total***
Car	42%	1%	2%	0%	45%
Train	3%	18%	1%	0%	22%
Bus	4%	0%	14%	0%	18%
Ferry	1%	1%	1%	12%	15%
Total	*49%*	*20%*	*18%*	*13%*	*100%*

When interpreting Table 10, it needs to be remembered that the SP scenarios held one third of fares to be set as they were at the time of the survey, one third to be higher, and one third to be lower. Thus, the totals should be roughly the same as those in Table 9 if people respond to a fare increase in exactly the opposite way to a fare decrease. However, this is not quite the case, with more people choosing 'car' in the stated preference experiment than in real life. It seems that very few people are willing to change from car travel to public transport, no matter what the change in public transport fares. Instead of train and bus, most people's alternative mode is the car, while ferry users seem to have a range of other modes they are willing to change to.

4.3.2 Ticket choice

Table 11 shows the number of respondents choosing each ticket type within each mode both currently and when asked to choose an alternative way to make that same trip.

Table 11 shows that most people chose a single public transport fare when choosing an alternative to their current form of travel. This could be partly due to uncertainty about alternative modes, so there might be a further move to periodical tickets (eg weeklies) once people become comfortable with and have knowledge about the new mode.

Table 11 Current and alternative ticket type choices of sample

Ticket Type	Current %	Alternate %
Train Single/Return	9	15
Train Off Peak Return	**4**	**3**
Train Weekly/Periodical	9	3
Train TravelPass (BFT)	1	1
Bus Single	11	31
Bus TravelTen	5	5
Bus TravelPass (BF)	1	1
Bus TravelPass (BFT)	0	3
Ferry Single	6	1
Jetcat Single		0
Ferry TravelTen	4	0
Jetcat TravelTen	1	0
Ferry TravelPass (BF)	2	0
Ferry TravelPass (BFT)	3	1
Car	45	37

4.4 Fare and mode elasticities

Several mode/ticket type choice models were estimated for the commuting and non-commuting markets. The survey provided good data for testing each market's sensitivity to varying levels of fares for each ticket type. The final set of direct and cross elasticities is reported in the table in Appendix 3. The elasticities illustrate the amount of change in the market share of a ticket type which occurs for every % change to a fare.[3]

4.4.1 **Results and implications**

The results suggest that for direct elasticities:

- commuters are generally less sensitive to fare changes than are non-commuters for the equivalent ticket type and mode
- sensitivity within a market increases from a single ticket through to multiple-trip tickets.

Consumers' reaction to fare increases will affect whether revenue will increase or decrease. If a small increase in the fare causes many consumers to no longer use a service, the overall result may be a decline in revenue from that service.

The travel decisions of regular users of transport services (eg those who purchase multi-trip tickets) are sensitive to fare changes. It is possible that a small increase in the fare available to a regular user could cause a decline in demand large enough to reduce overall revenue from that fare. While some people would transfer to other tickets (such as single cash tickets) there would also be a reduction in the overall use of public transport.

[3] An elasticity of -0.08 means that a 1% increase (or decrease) in fares would lead to a reduction (increase) in purchase of this ticket of only 0.08%.

Conversely, the travel decisions of users of cash tickets are less sensitive to the level of fares. An example of this can be seen in the train non-commuter market (see Table 12). Here the average direct fare elasticity is -0.093 for a single ticket and -0.691 for a weekly ticket. People purchase multi-trip fares because they are cheaper (per trip), quicker, and more convenient than buying a number of single fares. The higher elasticities for the multi-trip tickets which have a higher dollar value imply that increases in these fares are not as acceptable as a similar proportionate increase for the single ride fares. Thus, the impact on the market at the margin is greater. This has interesting implications for fares policy. For example, increasing the price of a single ticket offers higher revenue growth prospects with smaller losses of patronage than is the case for similar percentage increases in weekly tickets, TravelPasses, TravelTens and multi-modal tickets.

Direct elasticities for CityRail

Table 12 shows the fare elasticities for each of the CityRail ticket types. The principal ticket types for transporting commuters to and from the CBD in peak hour are the weekly ticket and TravelPass. While these ticket types have low price elasticities, they are more sensitive to price changes than fares paid by occasional train travellers using single and off-peak tickets.

Table 12 Fare elasticities for trains

Ticket type	Commuters	Non-commuters
Train Single	-0.08	-0.093
Train Off-Peak	-0.123	-0.043
Train Weekly	-0.25	-0.691
Train TravelPass	-0.529	-1.103

(Source: Hensher and Raimond, *Evaluation* of Fare Elasticities *for the Sydney Region,* March 1996.)

The elasticities calculated in this study can be compared to those that CityRail uses (Table 13). CityRail[4] uses combined commuting and non-commuting elasticities and only report direct elasticities, presumably because the estimation method used was unable to produce cross elasticities. Elasticities for separate ticket types have not been calculated by CityRail. However, CityRail has calculated separate elasticities for journeys that involve (or do not involve) travel to the CBD.

[4] CityRail submission to the inquiry, Section 9 p 8.

Table 13 Elasticity values for CityRail services

Distance	CBD/Non CBD	Period	Fare
Short	CBD	Peak	-0.29
		Off-peak	-0.62
	Non CBD	Peak	-0.78
		Off-peak	-0.66
Medium	CBD	Peak	-0.19
		Off-peak	-0.25
	Non CBD	Peak	-0.28
		Off-peak	-0.36
Long	CBD	Peak	-0.08
		Off-peak	-0.12
	Non CBD	Peak	-0.18
		Off-peak	-0.21

(Source: SRA. On Track 1995, Submission to GPT, Section 9 p 8.)

Peak travel estimates presented by CityRail range from -0.08 to -0.78 (with the lowest estimate applying to long trips to the CBD, and the higher estimates applying to short non CBD trips). Off-peak travel estimates vary from a low of -0.12 for long trips to the CBD to -0.66 for short non CBD trips. These estimates appear to come from an SP study in which no distinction was made between the types of tickets. Thus, CityRail assumes an average fare per trip, regardless of the nature of the purchased ticket.

The single ticket direct elasticities of -0.08 for commuters and -0.093 for non-commuters estimated in the ITS survey fall at the bottom of the ranges currently used by CityRail. The estimates for weekly and TravelPass tickets for commuters also lie within the range currently used by CityRail. The only major difference relates to the non-commuting weekly and TravelPass tickets for which ITS found significantly higher elasticities. However, differences between the CityRail and ITS surveys limit the comparisons which can be made.

The results of the ITS analysis reflect the market environment in which commuters and non-commuters make choices. The results provide a better understanding of how travellers respond to fare profiles, which is not always obvious in the actual market. The fare profiles are of interest to the Tribunal as potential alternatives to the current data.

Direct elasticities for bus fares

Table 14 shows the sensitivity of bus travellers to fare changes.

Table 14 Fare elasticities for buses

Ticket type	Elasticity
Single	**-0.078**
TravelTen	-0.383
Bus travel on Bus/Ferry TravelPass	-0.813
Bus travel on Bus/Train/Ferry TravelPass	-0.822

(Source: Hensher and Raimond, *Evaluation of Fare Elasticities for the Sydney Region,* March 1996.)

As can be seen, a one % increase in the price of a single fare will lead to a reduction in the number of passengers using that ticket of only 0.078%. In contrast, a one % increase in the price of a TravelTen or TravelPass results in a 0.383 or 0.813% reduction in the use of these ticket types respectively.

Direct elasticities for ferries

Table 15 gives the direct elasticities for ferries.

Few TravelPasses are sold to people other than commuters. Thus, a substantial increase in all tickets other than the JetCat TravelTen would increase net revenue.

Tourist and leisure travellers make up the majority of the market (see Table 8). These travellers are also the least affected by a change in price. An increase in the price of off-peak and single fares would have little effect on the level of patronage, but would result in a significant increase in revenue.

Table 15 shows that single tickets purchased in the peak and more particularly, in the off-peak have a very low demand elasticity. An increase in price will have very little effect on the number of people using that ticket type. The result will be a considerable increase in revenue. This fare is purchased mostly for leisure or tourist purposes.

Table 15 Fare elasticities for ferries

Fare type	Elasticity
Commuters	
Ferry single	-0.183
JetCat single	-0.268
Ferry TravelTen	-0.344
JetCat TravelTen	-1.943
Ferry on bus/ferry TravelPass	-0.347
Ferry on bus/train/ferry TravelPass	-0.308
Non-commuters	
Ferry single	-0.042
JetCat single	-0.199
Ferry TravelTen	-0.436
JetCat TravelTen	-1.612
Ferry on bus/ferry TravelPass	-0.718
Ferry on bus/train/ferry TravelPass	-1.296

(Source: Hensher and Raimond, 1996.)

Cross elasticities

Cross elasticities between public transport and motor vehicle travel are low. This suggests that a "modest" public transport fare increase would result in few travellers switching to cars because public transport users are either unable to use a car for travel or do not have access to parking. It may also reflect the availability of good quality public transport. It will certainly reflect the fact that the relative price of public transport and car usage is distorted because of the general absence of correct road pricing signals. The fact that only relatively few people would switch to cars following a real fare increase supports the belief that a large proportion have chosen to use public transport because of the relative qualities and costs of using public transport for work or leisure travel. In the long run, this quality and price relativity must be maintained in order to prevent a gradual shift to car use and, hence, an increase in demand for road space with an accompanying increase in externality costs.

Evidence suggests that the demand for public transport is not responsive to fare changes. Responses to the substantial real changes in fares in the 1970s provide examples of this. Fares were reduced by 20% in 1976 and then increased by 7-10% in real terms over each of the following four years. Demand appeared to change little in response to these substantial changes in price. STA estimates that the 20% reduction in fares may have increased demand by only 1.8%.[5]

The important implication of this is that lowerfares will not attract large numbers of people to the public transport system. In particular, lower fares will persuade very few car users to switch to public transport

Table 16 demonstrates how existing users of private or public transport would respond to changes in public transport fares by altering their travel patterns.[6]

Table 16 Direct and cross elasticities' for commuter market

	Rail	Bus	Private cars
Rail	**-0.25**	**0.004**	**0.009**
Bus	0.009	**-0.383**	**0.005**
Private cars	0.015	0.007	-0.014

If you extrapolate from these results, these results suggest that:

A **5%** increase in commuter rail fares would result in:

- a reduction in commuter rail travel of 1.25%
- an increase in commuter car travel of **0.07%**
- an increase in commuter bus travel of 0.05%

A 5% increase in commuter bus fares would result in:

- a reduction in commuter bus travel of 1.9%
- an increase in commuter car travel of 0.05%
- an increase in commuter rail travel of 0.02%

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5 STA, *Submission to the Transport Pricing Review*, p 63.

6 This table has been prepared for illustration purposes. The rail weekly has been used as the commuter rail fare and the TravelTen, as the bus commuter fare.

7 A direct elasticity of -0.25 means that a 1% increase (or decrease) in fares would lead to a reduction (or increase) in purchases of this ticket of only 0.25% Conversely a cross-elasticity of 0.005 (eg private cars-bus) means that a 1% increase in pricing for car users would result in a 0.005% increase in purchases of bus tickets. To extrapolate these, a 5% increase in pricing for cor users would result in a 0.025% (5 ? .005 %) increase in purchases of bus tickets.

A 5% increase in costs of travel by private cars would result in:

- a reduction in commuter car travel of 0.07%
- an increase in commuter rail travel of 0.05%
- an increase in commuter bus travel of 0.03%.

These results suggest that patronage would not be affected greatly by a modest increase in rail fares, particularly if increases in the periodical tickets were minimised. If these elasticities are reasonably accurate, the social benefits of rail travel would not be greatly affected by modest fare increases. However, revenue would increase and the need for deficit funding of operating costs by taxpayers could be reduced.

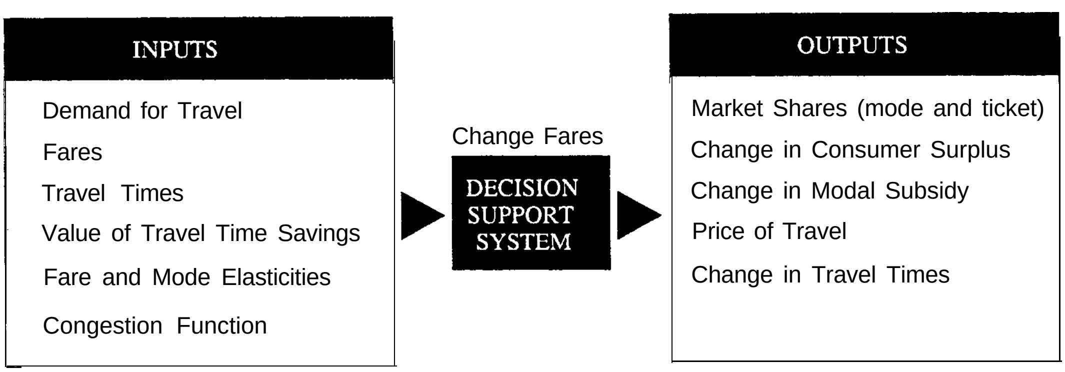
Increases in travel costs for car users would have little impact on the use of public transport.

4.5 The decision support system

As part of this study, ITS developed a decision support system (DSS) to enable the Tribunal to assess the impact of alternative fares on revenue, patronage, subsidy and road traffic congestion. Through user-friendly 'point and click' technology, the user of the DSS can select base and application levels and / or percentage changes in fare levels for all 14 ticket types as well as the price of car travel. By varying the price of automobile travel, one can investigate the indicative implications of 'road pricing'.

The inputs to and outputs from the DSS for each market segment are shown in Figure 8.

Figure 8 inputs and outputs of the decision support system



In the model, a change in consumer surplus* provides a measure of change in net benefit. Change in subsidy per mode represents the change in funding required as a result of a

[8] Consumer surplus is a measure of what people gain from trade. It is the difference between what people are willing to pay and what they do pay. The change in consumer surplus is of interest in assessing fare changes. The figure below illustrates the change in consumer surplus.

change in revenue. An important consideration is whether **the** net benefit is greater than the loss of revenue.

An example of the input and output main screen after a run is shown below.' h-t this example the bus and train fares have been reduced by 10%. This shows that the total revenue to public transport has reduced by $77,320. The net benefit has increased by $81,910. Thus benefit is greater than revenue loss. However, for some ticket types the net benefit is less than the revenue loss. In this example, this is partly due to people moving off ticket types to other ticket types for the same mode.

The ITS DSS can be used to identify the change in average travel speed as a measure of changes in congestion associated with fare changes. To do this we need to establish how the travel times for a given distance are affected by a switch into or from car use. Since car travel influences the volume capacity ratio on the road network, we need to map the between change in car market share and the volume/capacity ratio, with the latter influencing travel time over distance.

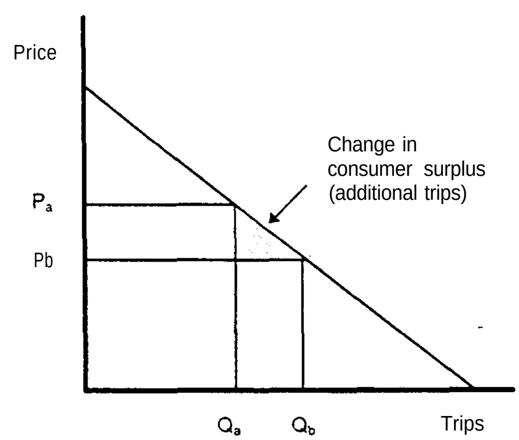
To calculate average travel time, the model uses the Bureau of Public Roads (BPR) function (BPR 1964) which is commonly used by network planners. The general form of the travel time function is represented as follows.

$$T = T^{0} [1 + \alpha(V/C)^{\beta}]$$

where

T	=	travel time
T^0	=	travel time under zero trip conditions (ie distance/free flow speed)
v	=	number of trips (demand between an origin and destination-OD demand)
c	=	synthetic capacity from a zone to another zone

The parameters a and β, are the inverse of the modal speeds. ITS undertook extensive testing to identify appropriate parameter values for α and β. Network data had to be prepared and checked carefully. To ensure that the relationships between travel time, speed, volume and capacity remain sensible over time, ITS established that the values of α = 1.1 and β = **2.1** would ensure this for all cities in Australia.



When price falls from P_a to P_b, the quantity demanded increases from Q_a to Q_b, and the change in consumer surplus generated by additional trips is the shaded triangle.

Return to Title Screen

Commuters

Read Help

	Mode / Ticket Type	Before: Single Trip Fare	Before: Total Demand (average no. of one way trips per day)	Before: Market Share %	Before: Pub Transport Revenue (x 1000)	Before: Travel Time (mins)	After: Single Trip Fare	After: Total Demand (average no. of one way trips per day)	After: Market Share %	After: Pub Transport Revenue (x 1000)	After: Travel Time (mins)	After-Before Differences: Δ Market Share %	After-Before Differences: Pub Transport Δ Revenue (x 1000)	After-Before Differences: ΔB (Net Benefit) (x 1000)	After-Before Differences: ΔB / ΔRevenue	After-Before Differences: Δ Travel Time (secs)
Train	Single	$2.85	42,786	3.37%	$121.94	33.00	$2.55	42,187	3.33%	$106.23	33.00	-0.047%	($15.71)	$12.67	-0.81	
Train	Off-Peak Ret	$1.55	3,220	0.25%	$4.99	25.00	$1.35	3,168	0.25%	$4.21	25.00	-0.004%	($0.78)	$0.63	-0.82	
Train	Weekly	$2.50	127,890	10.09%	$319.73	50.00	$2.25	128,784	10.16%	$292.04	50.00	0.071%	($27.68)	$32.21	-1.16	
Train	Travelpass (BFT)	$2.40	21,805	1.72%	$52.33	63.00	$2.15	22,223	1.75%	$48.80	63.00	0.033%	($3.53)	$5.56	-1.57	
Bus	Single	$1.55	53,456	4.22%	$82.86	23.00	$1.35	51,842	4.09%	$68.06	23.00	-0.127%	($14.79)	$10.39	-0.70	0.0
Bus	TravelTen	$1.00	88,552	6.98%	$88.55	26.00	$0.90	88,888	7.01%	$80.34	26.00	0.026%	($8.21)	$8.89	-1.08	0.0
Bus	Travelpass (BF)	$0.94	40,732	3.21%	$38.29	48.00	$0.80	42,296	3.34%	$35.26	48.00	0.123%	($3.03)	$5.94	-1.96	0.0
Bus	Travelpass (BFT)	$0.91	48,999	3.86%	$44.59	30.00	$0.80	50,478	3.98%	$41.72	30.00	0.117%	($2.87)	$5.56	-1.94	0.0
Ferry & JetCat	F Single	$2.91	5,348	0.42%	$15.56	40.00	$2.90	5,283	0.42%	$15.15	40.00	-0.005%	($0.41)	$0.05	-0.13	
Ferry & JetCat	JC Single	$4.80	1,322	0.10%	$6.35	15.00	$4.80	1,308	0.10%	$6.22	15.00	-0.001%	($0.13)	$0.00	0.00	
Ferry & JetCat	F Ten	$1.75	4,738	0.37%	$8.29	34.00	$1.75	4,721	0.37%	$8.24	34.00	-0.001%	($0.06)	$0.00	0.00	
Ferry & JetCat	JC Ten	$3.95	896	0.07%	$3.54	24.00	$3.95	888	0.07%	$3.48	24.00	-0.001%	($0.06)	$0.00	0.00	
Ferry & JetCat	F Travelpass (BF)	$1.40	4,230	0.33%	$5.92	31.00	$1.40	4,215	0.33%	$5.88	31.00	-0.001%	($0.04)	$0.00	0.00	
Ferry & JetCat	F Travelpass (BFT)	$1.45	2,658	0.21%	$3.85	31.00	$1.45	2,650	0.21%	$3.83	31.00	-0.001%	($0.02)	$0.00	0.00	
	Car	$1.35	821,344	64.78%	N/A	23.00	$1.35	819,046	64.59%	N/A	23.00	-0.181%	N/A	$0.00	N/A	0.0
	Totals		1,267,976	100.00%	$797			1,267,976	100.00%	$719		0.00%	($77.32)	$81.91	-1.06	

- ● Commuters
- ○ Non-Commuters

Change Fares | Revenue Graph | After = Before | Share Graph | Ticket prices | Print screen

- ● Fit To Screen
- ○ Show Full Size

Value of Time	$10.00/hr,	$0.17/mi
Demand Before	1,267,976	
Agg. Δ in Travel time - bus	0 Hours	
Agg. Δ in Travel time - car	0 Hours	

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APPENDIX 1 FULL RANGE OF FARES USED IN EXPERIMENTS

All fares have been rounded to the nearest 10 cents. The low fare is 50% below current levels, and the high fare is 50% above current levels.

TRAIN

Trip Length	Low Fare	Current Fare	High Fare
Single (with off peak return shown in brackets)			
Short	$0.80 ($0.90)	$1.60 ($1.80)	$2.40 ($2.60)
Medium	$1.30 ($1.40)	$2.60 ($2.80)	$3.90 ($4.20)
Long	$1.80 ($2.00)	$3.60 ($4.00)	$5.40 ($6.00)
Weekly			
Short	$6.80	$11.50	$18.30
Medium	$9.70	$19.40	$29.00
Long	$13.20	$26.00	$40.00
TravelPass			
Short	$10.00	$20.00	$30.00
Medium	$14.00	$28.00	$42.00
Long	$20.00	$39.00	$59.00

BUS

Trip Length	Low Fare	Current Fare	High Fare
Single			
Short	$0.60	$1.20	$1.80
Medium	$1.30	$2.50	$3.80
Long	$2.00	$3.90	$5.90
TravelTen			
Short	$4.00	$8.00	$12.00
Medium	$8.00	$16.00	$24.00
Long	$16.00	$32.00	$48.00
TravelPass (Bus/Ferry)			
Short	$8.60	$17.10	$26.00
Medium	$11.70	$23.00	$35.00
Long	$17.20	$34.00	$52.00
TravelPass (Bus/Ferry/Train)			
Short	$10.00	$20.00	$30.00
Medium	$14.00	$28.00	$42.00
Long	$19.50	$39.00	$59.00

FERRY

Trip Length	Low Fare	Current Fare	High Fare
Single			
Short	$1.40	$2.80	$4.20
Medium Ferry	$1.80	$3.60	$5.40
Medium Jetcat	$2.40	$4.80	$7.20
Long	$2.10	$4.20	$6.30
FerryTen			
Short	$8.20	$16.40	$25.00
Medium Ferry	$12.30	$25.00	$37.00
Medium Jetcat	$19.80	$40.00	$59.00
Long	$14.50	$29.00	$44.00
TravelPass (Bus/Ferry)			
Shot-t	$8.60	$17.10	$26.00
Medium	$11.70	$23.00	$35.00
Long	$17.20	$34.00	$52.00
TravelPass (Bus/Ferry/Train)			
Short	$10.00	$20.00	$30.00
Medium	$14.00	$28.00	$42.00
Long	$19.50	$39.00	$59.00

APPENDIX 2 EMPIRICAL EVIDENCE 'ON CROSS ELASTICITIES FROM PREVIOUS STUDIES

Table A1 summarises the available evidence on cross elasticities relevant to traveller responses to changes in urban public transport fares. The findings are rather limited. Indeed, authors such as Glaister and Lewis (1978) have stated that the evidence on elasticities for the impact of public transport fares on car traffic for the off-peak are largely guesswork. The cross elasticities for rail and bus with respect to bus and rail fares are very similar, with an unweighted average value of 0.24 ± 0.06. However, the car-to-public transport and public transport-to-car cross elasticities are different. The average cross elasticity of car demand with respect to bus fares is 0.09 ± 0.07; and with respect to tram fares it is 0.08 ± 0.03. These values are significantly higher for travel to CBD destinations where the choice of public transport is greater (ie higher initial modal share).

This evidence is based on studies using data collected primarily in the 1970s. The studies from which the reported cross elasticities are drawn do not examine any variations in the cross elasticities with respect to ticket type, trip length, or time of day. The estimates in Table 1 which distinguish time of day refer to modal substitution within that period, not substitution of travel by a given mode between times of the day Using unpublished data from a number of USA consultant cross section studies, Ecosometrics (1980) have estimated peak/off-peak fare cross elasticities ranging between 0.03 and 0.38 for peak demand elasticity by comparison with off-peak fares, and 0.02-0.03 for off-peak demand elasticity with respect to peak fares. The wide range of peak demand elasticities for off-peak fares compared to the off-peak elasticity suggests that there is greater flexibility in switching from the peak to the off-peak than vice versa. This seems counter-intuitive and requires further empirical investigation.

Evidence on the cross elasticities associated with *fare sfrucfures* is almost impossible to find. There are examples throughout the world of spatially structured fare regimes such as graduated fares, zone-based fares and flat-fares; in addition there *is* temporal differentiation, including peak vs off-peak, daily tickets, weekly tickets, seasonal tickets and a whole range of socioeconomic scales (children, pensioners, excursions etc). The aim of this review is not to evaluate the advantages and disadvantages of these alternative fare structures and the implications of a particular mix, but rather, to seek out any empirical evidence on how the market has responded to changes in one or more of these fare types given the available set of fares on offer. There is a clear need for empirical research on the topic.

Table Al A synthesis of the empirical evidence on the cross elasticity of urban public transport fares

Elasticity Context	Result	Data Type	Reference
Car use with respect to bus fares for peak work trips:			
London (1970-75)	0.06	Time Series	Lewis (1977)
Boston (1965)	0.14	Cross section	Kraft and Domencich (1972)
Cook County, Illinois (1961)	0.21	Cross section	Warner (1962)
San Francisco (1973)	0.12	Cross section	McFadden (1974)
Melbourne (1964)	0.19	Cross section	Shepherd (1972)
Car use with respect to train fares for peak work trips:			
Sydney **(1976)**	0.09	Before & after	Hensher and Bullock (1979)
Car use with respect to bus and train fares for peak work trips:			
Sydney (1981)	0.06	Cross section	Madan and Groenhout (1987)
Rail use with respect to bus fares for peak work trips:			
San Francisco (1973)	**0.28**	Cross section	McFadden (1974)
London (1970-75)	0.14	Time series	Glaister and Lewis (1978)
Rail use with respect to bus fares for off-peak travel:			
San Francisco	**0.28**	Cross-section	McFadden (1974)
Rail use with respect to bus fares for all hours:			
London **(1970-73)**	0.25	Weekly time series	Fairhurst and Morris (1975)
Bus use with respect to rail fare for peak work trips:			
San Francisco (1973)	0.25	Cross section	McFadden (1974)
London (1970-75)	0.14	Time series	Glaister and Lewis (1978)
Bus use *with respect to rail fares for off peak trips:*			
London **(1970-75)**	**0.28**	Time series	Glaister and Lewis (1978)
Car use with respect to rail fares for peak work trips:			
San Francisco (1973)	0.13	Cross section	McFadden (1974)
London (1970-75)	0.06	Time series	Glaister and Lewis (1978)
Bus use with respect to rail fares for all hours:			
London (1970-73)	0.25	Time series	Fairhurst and. Morris (1975)

APPENDIX 3 DIRECT AND CROSS ELASTICITIES

Interpretation of Table A2

Each column provides one direct share elasticity and 14 cross share elasticities. A direct or cross elasticity represents the relationship between a percentage change in fare level and a percentage change in the proportion of daily one-way tips by the particular mode and ticket type.

For example, the column headed TNS (train single fare) in the 'commuting' section tells us that a 10% increase in the train single fare leads to a 0.8% reduction in the proportion of daily one-way trips by train on a single fare. In addition, this 10% single fare increase leads to a 0.48% higher proportion of one-way train trips by off-peak return tickets, a 0.1% increase in one-way trips using weekly tickets, and a 0.14% increase in one-way trips using a train TravelPass.

Table A2 Matrix of direct and cross elasticities

Elasticities for Commuter and Non Commuter Markets (Based on lull sample of 614 Interviews)

Commuter Market

Note: *read for fare/*TNS as column	TNS	TNOP	TNW	TNTP	BSS	BSTT	BSTPBF	BSTPBTF	FRS	JCS	FRTEN	JCTEN	FRTPBF	FRTPBTF	CAR
Train single	-0.08	0.033	0.123	0.141	0.002	0.01	0.008	0.009	0.002	0	0.01	0	0.01	0.011	0.014
Train off-peak	0.046	-0.123	0.161	0.2	0.003	0.011	0.01	0.011	0.003	0	0.008	0	0.008	0.008	0.016
Train weekly	0.01	0.012	-0.25	0.059	0.001	0.004	0.003	0.003	0	0	0.006	0	0.007	0.008	0.009
Train TravelPass	0.014	0.013	0.084	-0.529	0.001	0.008	0.006	0.007	0.001	0	0.01	0	0.01	0.01	0.011
Bus Single	0.002	0.002	0.011	0.013	-0.076	0.165	0.171	0.162	0.001	0.001	0.005	0.001	0.005	0.005	0.006
Bus travel ten	0.001	0.001	0.009	0.01	0.025	-0.383	0.087	0.098	0.001	0.001	0.007	0.001	0.006	0.007	0.005
Bus on Bus/Ferry TravelPass	0.002	0.002	0.011	0.013	0.04	0.133	-0.813	0.147	0.001	0.001	0.006	0.002	0.005	0.006	0.005
Bus on Bus/Train/Ferry TravelPass	0.002	0.001	0.009	0.01	0.033	0.116	0.113	-0.622	0.001	0.001	0.006	0.001	0.006	0.006	0.005
Feny Single	0.011	0.01	0.056	0.057	0.005	0.027	0.022	0.025	-0.183	0.034	0.209	0.041	0.212	0.217	0.004
JetCat Singb	0.002	0.002	0.012	0.015	0.009	0.045	0.039	0.046	0.062	-0.268	0.194	0.092	0.188	0.196	0.003
Ferry Travel Ten	0.002	0.001	0.022	0.016	0.001	0.008	0.004	0.006	0.011	0.006	-0.344	0.008	0.071	0.065	0.002
Jet Cat Travel Ten	0.002	0.001	0.011	0.015	0.007	0.036	0.032	0.038	0.070	0.095	0.145	-1.943	0.194	0.213	0.004
Ferry on Ferry/Bus TravelPass	0.002	0.001	0.021	0.017	0.001	0.008	0.005	0.006	0.01	0.006	0.068	0.007	a.347	0.082	0.002
Feny on Ferry/Bus/Train TravelPass	0.001	0.001	0.018	0.013	0.001	0.006	0.004	0.005	0.008	0.005	0.054	0.006	0.054	-0.308	0.002
Car	0.001	0.001	0.015	0.013	0.001	0.007	0.004	0.006	0.008	0.006	0.004	0.005	0.004	0.005	-0.014

Non-Commuter Market

Note: read for fare/TNS as column	TNS	TNOP	TNW	TNTP	BSS	BSTT	BSTPBF	BSTPBTF	FRS	JCS	FRTEN	JCTEN	FRTPBF	FRTPBTF	CAR
Train Single	-0.093	0.034	0.141	0.138	0.004	0.017	0.013	0.008	0.003	0	0.011	0	0.008	0.005	0.019
Train off-peak	0.012	-0.043	0.039	0.04	0.002	0.009	0.005	0.003	0.002	0	0.007	0	0.004	0.002	0.014
Train weekly	0.04	0.031	-0.691	0.123	0.004	0.017	0.014	0.008	0.002	0	0.01	0	0.007	0.005	0.017
Train TravelPass	0.042	0.032	0.126	-1.103	0.003	0.016	0.014	0.009	0.002	0	0.01	0	0.007	0.005	0.015
Bus Single	0.001	0.001	0.004	0.004	-0.035	0.07	0.068	0.053	0	0	0.002	0.001	0.001	0.001	0.005
Bus travel ten	0.001	0.001	0.003	0.003	0.013	-0.22	0.058	0.046	0	0	0.002	0.001	0.001	0.001	0.004
Bus on Bus/Ferry TravelPass	0.002	0.002	0.006	0.007	0.028	0.129	-0.732	0.143	0	0	0.001	0	0.001	0.001	0.005
Bus on Bus/Train/Ferry TravelPass	0.001	0.001	0.005	0.005	0.037	0.17	0.254	-1.046	0	0	0	0	0	0	0.006
Feny Single	0.002	0.003	0.005	0.005	0.001	0.004	0.001	0.001	-0.042	0	0.062	0.011	0.043	0.028	0.006
JetCat Single	0.001	0.001	0.004	0.004	0.004	0.021	0.009	0.004	0.034	-0.199	0.181	0.114	0.166	0.139	0.002
Ferry Travel Ten	0.002	0.005	0.008	0.008	0.001	0.005	0.002	0.001	0.02	0.009	-0.436	0.015	0.06	0.042	0.007
Jet Cat Travel Ten	0.001	0.001	0.004	0.004	0.005	0.02 1	0.01	0.005	0.04 1	0.095	0.166	-1.812	0.198	0.166	0.002
Ferry on Ferry/Bus TravelPass	0.004	0.005	0.013	0.013	0.002	0.01	0.004	0.002	0.032	0.02	0.157	0.031	-0.718	0.099	0.008
Ferry on Ferry/Bus/Train TravelPass	0.006	0.007	0.017	0.019	0.002	0.012	0.006	0.003	0.04	0.043	0.226	0.063	0.216	-1.296	0.01
Car	0.001	0.001	0.002	0.002	0.001	0.008	0.005	0.004	0	0	0.001	0	0.001	0	-0.006