Value of Travel Time Revisited – NSW Experiment

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Abstract

One of the principal outputs of any transport improvement project is time saving-that is accomplishing the same transport task in less time.

While it may be easy to indicate the benefits of transport improvements which result in higher speeds and level of service, calculation of their dollar value is considerably complex.

There is a dichotomous body of studies in determining the value of travel time. One stream, mainly theoretical, is where marginal productivity of working time is most commonly used in valuing travel time. The other stream is based on consumer behaviour. This study is to carry out an empirical analysis to independently estimate the value of travel time (VTT) and compare this with the current value used in economic appraisal of transport investment in NSW which is based on proportion of wage.

The basic methodology is based on consumer behaviour through stated preference survey where a choice is exercised between slower cheaper and faster more expensive options. The paper discusses the stated preference survey conducted to gather data of real value from public transport users (train, light rail, bus and ferry). This is part of a study that will also include values of time for car drivers and passengers, which at the writing of this paper is still in the survey stage. Some comments are made in the paper on the use of internet panels as a surveying method.

# Introduction

One of the most important economic parameters is the value of travel time, as the value of travel time savings represents the dominant economic benefit of road and transport projects, typically accounting for 60% to 80% of quantified economic benefits.

The value of travel time for use in transport modelling and economic appraisal is informed by 3 sets of consideration:

* Evidence – maybe theoretical, empirical or both
* Policy – Government may choose to apply value of VTT savings in particular way for evaluation of public projects, despite acceptance that VTTS varies with socio-economic characteristics
* Practicality – Governments must ensure that official procedures are practical and cost effective for the use to which they will be put

Transport for NSW (TfNSW) released the [*Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives*](http://www.transport.nsw.gov.au/sites/default/files/b2b/publications/tfnsw-principles-and-guidelines-for-economic-appraisal-of-transport-initiatives.pdf)(PGEATII) in March 2013 which presents the economic parameter values for use in economic appraisals of roads and transport projects including travel time values.

The TfNSW economic appraisal guidelines recommend value of travel time based on marginal productivity of working time. Private travel time is valued at 40% of the average hourly earnings, applicable for travel modes of private car, motorcycle, bicycle, pedestrian and public transport for commuting and recreational trip purposes. The proportion of 40% was supported by the first wave of stated preference studies undertaken in the UK in the 1980s. It is worth noting that 40% was recommended by Austroads in 1997 for ‘all’ time walking, waiting and in-vehicle time for both car and public transport. The Business travel time is valued at 128% of the average hourly earnings of the population, applied for all business trips. The 128% of average weekly earnings were recommended by Austroads (2012), comprising the business time valued at 135% of AWE less payroll tax of 7%. The original assumption is that time spent travelling for business purposes is unproductive and therefore foregone working time. This assumption is now a subject of further research.

The TfNSW economic appraisal guidelines recommend the same value of private travel time for all transport users and trip purposes mainly based on the following considerations:

* Public transport users and car drivers should be treated the same in making investment decisions and resource allocations. If a lower value of travel time for public transport users is used, public transport projects will be disadvantaged in the resource allocation process.
* Previous studies suggested that, if the effect of public transport fare concessions is isolated, the values of travel time of car users and public transport users are close.[[1]](#footnote-1)

The following are the travel time values included in the TfNSW economic appraisal guidelines (in 2013/14 $).

* Value of travel time (private) = $15.14 per hour applicable to private car occupants, on-board train, on-board bus, ferry travel, cycling and walking.
* Value of travel time (business) = $48.45 per hour applicable for all business travels.

# Objectives of the NSW Stated Preference VTT study

The objective of this study is to provide the empirical evidence and shed some light on the value of non-work travel time in NSW. This study aims to determine the non-working time value through trade off with cost based on empirical approach by undertaking a stated preference survey. The study aims to validate whether the 40% relationship between the non-work travel time value and the average earnings still holds and therefore stable after almost 3 decades when it was first established (see Section 3). The study will also put value to the attribute relating to the reliability of car travel.

# Background and literature review

Before the establishment of the integrated transport agency in NSW, the Transport for NSW or TfNSW, the VTT for roads and rail in NSW has been derived using different approaches. The VTT for roads was largely sourced from Austroads (2012) while the values for rail were derived from a series of stated preference surveys conducted on rail passengers. Overall, the VTT for roads of $13.76 in 2011/12 prices is about 19% higher than value for rail travel of $11.62 (which includes concession and non-concession).

## 3.1 Austroads

Austroads, the association of Australasian road transport and traffic agencies. has undertaken research into travel time values for road users over the last two decades including a literature review of researches in Australia and overseas, especially the UK. It undertook a project in 1994 to develop national values of travel time for use in economic evaluation of road projects. There was a consensus by Austroads members to the following:

* Private travel time to include all private car, motorcycle, bicycle and pedestrian travel (including travel to and from work and recreational travel), waiting time and public transit and tourist passenger travel.
* Private travel time to be valued at 40% of the average hourly wage rate of the employed population.
* Business travel time includes travel for all modes, including taxi, hire and reward bus as well as light commercial, heavy rigid and articulated commercial vehicles
* No threshold limit for small travel time savings

Austroads (1997) agreed that all values were to be updated annually and reviewed every five years. Austroads has updated the parameter values every two years with the most recent update of travel time values done in March 2012 when Austroads released the Guide to Project Evaluation Part 4: Project Evaluation Data (Updated RUE Unit Values).

## 3.2 National Guidelines on Transport System Management (NGTSM)

The NGTSM recommends an overall standard value of time of $10.00 for all public transport which is different for peak ($10.80) and off-peak ($9.20) (ATC (2006). In the recent NGTSM update (December 2014), estimated values of travel time for cars and heavy vehicles have been included which were essentially derived from Austroads (2012). For private cars, the VTT is $14.99 (2013 $). Further researches are to be undertaken in valuing travel time reliability improvements, travel time savings for freight and light commercial vehicles and study into the distribution of travel time savings.[[2]](#footnote-2)

## 3.3 International practices

### 3.4.1 UK

In the UK, a single value is provided for all modes for the value of private travel time. It is also the same for all journey purposes. It is an average value which includes retired persons who have a lower value of travel time. Values of travel time have been sourced from the Values of Travel Time Savings in the UK (Mackie et al 2003). The equity value of private travel time is based on the average income of travellers on the journey to work and is updated using the growth in disposable income per head of population. It is assumed to hold for all individuals on all forms of non-work journeys.

### 3.4.2 USA

A single value of travel time is provided for all surface modes (e.g. car, rail, bus) and a separate value for air and high speed rail, in the US. The rationale is that where modes are close substitutes in location, purpose and trip distance it is assumed that incomes and preferences of travellers are distributed identically among modes leading to a common value of travel time, with the exception of air and high speed rail travellers which is 2.5 times greater than business travel and 1.9 greater than personal travel under surface modes. The median household income of these travellers is 2.5 and 1.9 times greater than the median household income for business and personal travel, respectively. Business travel time value is 100% of median hourly gross wage. Personal travel is assumed to be 50% of the hourly median household income (US DOT 2011).

### 3.4.3 Canada

Transport Canada adopts the same value of travel time for private value of travel time, an equal value is assigned regardless of mode and is 50% of the average wage while different values are adopted for different modes for business travel only, taking into account differences in employment costs among travellers across modes. Business travel time is valued at 100% of hourly cost to employee with bus and rail travellers having a lower value than car drivers. Guidance states that a lower value of travel time for business travellers should be used for modes which allow work to be done during the journey.

### 3.4.4 New Zealand

NZ has recently decided to adopt the use of equal value of travel time across modes for valuing travel time benefits in a circular issued in July 2013 regarding updates to the Economic Evaluation Manual. This change is to ensure each mode is treated equally (NZTA 2013).

Thus, for the value of private travel time, UK, USA, Canada and now New Zealand have used the same value. Different values of business travel time are used in UK and Canada. USA provided different values for air and high speed rail only. It is also worth noting that New Zealand only started to adopt the same value of travel time for all modes and trip purposes from July 2013.

The literature review shows that adopting the same value of time for private travel across land transport modes is more the general practice.

# TfNSW Value of Travel Time Study

The current TfNSW study aims to revisit the valuation issues particularly the 40% average earnings relationship for non-work travel time. The study is using Stated Preference surveys to estimates values for public transport, car, walk, cycle and taxi. At the time of writing, surveys have been undertaken of train, light rail, bus and ferry users and the data analysed. For car, the survey is at pilot stage and for walk, cycle and taxi, the surveys have yet to be designed.[[3]](#footnote-3) Thus the remainder of this paper concerns public transport users.

The PT surveys have built on surveys undertaken by the Bureau of Transport Statistics (BTS) in 2013 and Sydney Trains in 2014. These surveys built upon a study undertaken for the NZ Transport Agency in 2012-2013 which devised a cost-effective on-board approach, Douglas (2014).

In 2013, BTS undertook a suite of surveys as part of forecasting demand for a new CBD Light Rail service. One of the surveys was a self-completion SP questionnaire handed out and collected on buses, trains and light rail services in the inner west of Sydney. A total of 1,975 passengers responded: 576 bus, 471, light rail and 928 rail.[[4]](#footnote-4) In 2014, the same self-completion SP questionnaire was used by Sydney Trains with 889 responses obtained ‘network’ wide.[[5]](#footnote-5) Rail was considered to have been well sampled whereas ferry passengers were not surveyed and bus passengers were only surveyed in the inner west of Sydney.

The TfNSW Value of Time study ‘filled in the gaps’ by extending the coverage of the bus survey and developing a set of ferry questionnaires. The bus and ferry surveys were undertaken in 2014 with 1,134 bus users (including Newcastle and Wollongong) and 1,114 ferry users (Sydney plus Newcastle) surveyed. The combined result was a sample of 5,112 respondents covering bus, light rail, rail and ferry in metropolitan Sydney, Newcastle and Wollongong. Table 1 gives the samples and compares them with other studies.

The SP surveys were ‘mode-specific’, i.e., the choices related to the respondent’s travel mode.[[6]](#footnote-6) Thus the bus value of time was estimated for bus users and the train value for rail users. Generally, mode-specific surveys have been found to be more accurate at estimating values of time compared to surveys where respondents choose between different modes, for instance, bus versus rail. This is due to reduced propensity of respondents to trade-off in the former.

**Table 1: Sample sizes for each travel mode**

|  |  |  |
| --- | --- | --- |
| **Transport mode** | **TfNSW**  **Sample Size** | **Comment and Comparison with Other studies** |
| Pilot survey | Not required | The survey technique was developed in NZ and was further tested by BTS and Sydney Trains which meant that little ‘piloting’ was required for the TfNSW Value of Time study other than to verify the ferry questionnaire. |
| Bus | 1,710 | 1,478 useable respondents in Hensher (2001) Service Quality study. |
| Light Rail | 471 |  |
| Rail | 1,817 | 1,578 respondents in 2004 VTT studies  448 sampled in the UK by Steer Davies Gleave (2009) Network Rail New Line Programmes (long distance rail). |
| Ferry | 1,114 | 869 respondents in STA & Booz Allen & Hamilton study (2002) Planning Ferry Services |
| **Total** | **5,112** |  |

## 4.1 Survey scope

The SP survey includes five attributes: fare, in-vehicle time, service frequency, train quality and station quality. The questionnaire also included socio-economic and trip profile questions with surveyors recording the time and details of the service. The data enabled the sample profile to be assessed and the extent to which values of time varied by market segmentation.

A SP study in Sydney of 939 bus and rail passengers with varying levels of income has measured the impact on travel time values as a result of income standardisation, Douglas and Jones (2013). After standardising for income, the weighted average value of time was $13.05/hour (including GST). Excluding GST the value is lower at $11.87. If concession ticket holders are excluded, the value increases to $15.30/hr ($13.90 excl GST) which is close to the ‘all mode’ recommended value of $13.76/hr (2011-12 prices) in the TfNSW economic appraisal guidelines.

# Public transport value of time survey

To assist in addressing the issues raised on the value of travel time used in economic appraisal and to be in a strong position by being supported by empirical evidence, a stated preference method has been adopted both for the public transport and car driver/passenger surveys.

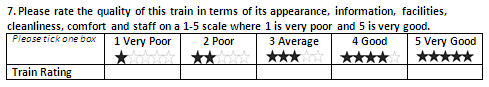
# Sampling, survey design, pilot and main surveys and statistical analysis have been undertaken and completed for the public transport modes (train, light rail, bus, and ferries) but only piloting has been undertaken for the car survey. Thus the remainder of the paper only discusses the findings of the public transport surveys.

In terms of surveying method, interviewing passengers at train stations and platform was ruled out because people had not experienced the quality of the trains. Although interviewing on trains on off-peak trains worked fine, on busier peak trains it was difficult because the interviewer had to stand in the aisle and lean over the passenger and it was very difficult to interview on moving buses. Self-completion questionnaires were therefore developed (an A4 sheet folded into a four page A5 sized booklet) which surveyors handed out on-board buses and trains offering pencils where necessary. Surveyors gave a short explanation of the task opening the booklet and taking passengers through the first choice. Except on very full trains and buses, which stopped surveyors moving around, the method worked well. A small scale internet panel was also tested but found to underestimate the value of time as Section 9 describes.

The underlying feature of the SP design was a time versus cost trade-off. Respondents were to choose between a service that was quicker but more expensive than the other. The choices also included differences in vehicle quality, station quality and frequency. Higher vehicle quality was associated with the faster/more expensive service although the times, fares and quality levels were specified in such a way that the attributes were uncorrelated. Station quality (like service frequency) was varied so sometimes higher station quality was with the faster/expensive service and sometimes with the slower/cheaper service.

Vehicle and stop quality were described using a star system similar to that used for films and restaurants.[[7]](#footnote-7) One star denoted very poor, three stars average and five stars very good. To familiarise respondents with the system, they were asked to rate their board stop/station at their bus, train or ferry before they did the SP. Figure 1 shows the train rating question.

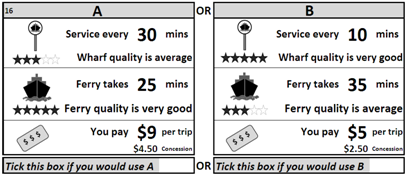
**Figure 1: Train quality question**



In the SP show-cards, each of the five attributes could take one of five levels. 25 experiments were required to estimate the time, cost and quality parameters which were split into three sets of 8, 8 and 9 questions. The ordering of the show cards was randomised and half the show-cards were ‘swapped around’ so that the cheaper mode was sometimes on the left and sometimes on the right.[[8]](#footnote-8)[[9]](#footnote-9)

Different ‘versions’ of the SP questionnaire were designed to tailor the time and fares closer to the actual trips made by respondents. Short, medium and long questionnaires were developed for bus and rail. Five questionnaires were developed for ferry to cover inner harbour, ‘Manly’ standard, fast ferry and the Newcastle-Stockton services. Designs were also developed for light rail and Newcastle bus services.

**Figure 2: Example ferry stated preference show card**



The differences in the times and costs between the two services (A and B) were kept the same in all the designs. What varied was the absolute times and costs so that for the ‘long’ questionnaires, the times and costs of services A and B increased by the same amount compared to the medium questionnaire. This enabled all the response to all the designs to be pooled without affecting the orthogonality of the underlying design.

A total of 5,496 SP questionnaires were returned. Of these, 384 (7%) had no response to any SP questionnaire (but did contain some answers to some of the profile questions). As each respondent answered eight or nine SPs, the number of SP observations exceeded the number of completed returned. In total, 40,175 SP observations were obtained (around 7.9 responses per completed SP questionnaire). The response to the 25 SP questions was approximately the same and did not require any balancing factors to be introduced.

**Table 2: SP observations and completed questionnaires**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Response | Bus | LRT | Rail | Ferry | All |
| SP Question Response | 13,285 | 3,598 | 14,462 | 8,830 | 40,175 |
| Completed SP Q'aires\* | 1,710 | 471 | 1,817 | 1,114 | 5,112 |
| Total Q'aires^ | 1,847 | 516 | 1,910 | 1,223 | 5,496 |
| Av SPs per Completed Q'aire | 7.8 | 7.6 | 8.0 | 7.9 | 7.9 |
| Notes: \* with at least one SP question completed ^ Total returned questionnaires with some questionnaires answered but no SP questions answered | | | | | |
|

# Aggregate analysis of response

One of the 25 SP show-cards was a straight time - cost trade-off (with frequency, vehicle and stop quality the same for services A and B). Service A was 10 minutes quicker than service B but cost $2 more. The threshold value of time required for a respondent to choose A was therefore $12/hour ($2 x 60/10). For respondents who were entitled to a fare concession, the fare was half implying a threshold value of $6/hr ($8.40/hr for light rail users with concessions set at 70% of the standard fare).

**Table 3: Response to SP question offering 10 minute time saving for $2**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Percent | | | | | Sample Size | | | | |
| Fare Type | Bus | LRT | Rail | Ferry | All | Bus | LRT | Rail | Ferry | All |
| Standard | 48% | 72% | 54% | 57% | 55% | 301 | 124 | 281 | 290 | 996 |
| Concession ^ | 44% | 67% | 52% | 32% | 46% | 225 | 18 | 174 | 77 | 494 |
| All | 46% | 71% | 53% | 51% | 52% | 526 | 142 | 455 | 367 | 1,490 |
| ^ concession fare was 50% of the standard fare for bus, rail and ferry & 70% for LRT | | | | | | | | | | |

Across the sample, 55% of standard fare respondents accepted the trade-off implying a median value of time above $12/hour. However, only 46% of concession respondents accepted the trade-off implying a median value of time less than $6/hr. Bus users were the least willing (46%) and light rail users the most willing (71%).

# Disaggregate analysis of response

The SP response was analysed by fitting equation 1 using maximum likelihood estimation.

where:

 ……(1)

Fare difference A-B in dollars (taking account fare concession (½ΔF) where appropriate)

Concession entitlement taking a value of 1 if entitled to a concession else zero

Difference in train time A-B in minutes

Difference in service interval A-B in minutes

Difference in train quality rating A-B ‘transformed’ by quality power function of 

Difference in station quality rating A-B (same as vehicle quality)

parameters to be estimated.

The five point quality rating scale was converted into a percentage scale ([Rating - 1]/4) so that very poor scored 0%, poor 25%, average 50%, good 75% and very good 100%. To keep the quality parameters the same sign (i.e. negative) as the cost and time attributes, the mirror image was specified (by subtracting the rating from 1). The percentage scale was transformed by applying a power parameter  to allow for sensitivity to diminish as the rating increased. In this way, an improvement from very poor to poor was valued more than an improvement from good to very good. Different values for the quality power function were tested with a value of 0.7 adopted for both vehicle and stop quality. Equation 2 shows the effect of the power function for a rating change from 60% to 70% which results in an 8% share of the maximum valuation (0%-100%) rather than 10%.

......(2)

Table 4 presents the estimated models for bus, rail, light and ferry. Two ‘all observation’ models are also presented; one with a constant and one without. Theoretically, the constant should be zero since there should be no underlying preference for service A or B. However, if the time-fare had been set either too low or too high respondents may have consistently favoured either the cheap or the quicker service. As can be seen, the constant was small (worth 0.4 minutes) and was statistically very weak. Thus in subsequent analysis, the constant was omitted.

All the attribute parameters had the correct sign and were statistically significant (t>1.96) except for light rail vehicle quality where the t value was 1.5. The most powerful attribute was service interval, followed by fare and in-vehicle time. Station quality was slightly weaker with vehicle quality the weakest attribute.

Values of time ($/hr) and relative valuations are given in the middle of the table. Values for standard fare passengers, concession fare passengers and the ‘average’ passenger (weighted according to the concession percentage).

The overall value of time was $14.39/hr for standard fare passengers with a concession value just under half that at $6.02/hr. With 31% of respondents using a concession, the weighted average value of time was $11.78/hr.

Bus passengers had the lowest value of time: $9.41/hr for standard fare passengers, $5.42/hr for concession passengers and $7.73/hr overall (42% concession). Light rail users had the highest values averaging $20.67/hr which reflected a low concession use (10%) and high average incomes ($63k p.a.). The rail and ferry values of time were broadly similar at $13.49/hr and $15.01/hr respectively.

In terms of the service frequency, light rail users valued service interval (minutes between departures) the highest with a relative IVT valuation of 0.73. The higher value was probably conditioned by the high frequency of service (every 13 minutes) and short waits (6 minutes) that light rail users experience. Ferry users had the lowest value of 0.36 which reflected the lower frequency service (every 32 minutes) they experience. Service interval was valued slightly higher by bus users (0.66) than by rail users (0.62).

The valuation of stop quality was consistent across the modes. Overall, the value of stop quality (very poor to very good) was worth 12.8 minutes. Vehicle quality was valued lower averaging 7 minutes. Light rail users had the lowest valuation which probably reflected their short trip times (13 minutes). Bus users had the highest valuation of very poor to very good of 8.2 minutes.

Table 4: Estimated models & relative valuations

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Bus | | LRT | | Rail | | Ferry | | All | | All-Constant | |
| β | |t| | β | |t| | β | |t| | β | |t| | β | |t| | β | |t| |
| Service Interval | -0.038 | 29.2 | -0.059 | 20.8 | -0.043 | 32.7 | -0.029 | 17.6 | -0.039 | 49.6 | -0.039 | 49.6 |
| In Veh Time | -0.058 | 20.5 | -0.080 | 13.6 | -0.069 | 24.6 | -0.082 | 22.4 | -0.067 | 39.9 | -0.066 | 30.6 |
| Fare | -0.370 | 30.0 | -0.224 | 10.0 | -0.254 | 21.4 | -0.275 | 19.8 | -0.278 | 40.8 | -0.282 | 33.6 |
| Fare Conc | -0.272 | 12.9 | -0.157 | 3.1 | -0.303 | 13.3 | -0.647 | 18.7 | -0.387 | 28.8 | -0.390 | 27.5 |
| Stop Quality | 0.717 | 12.6 | -0.918 | 8.3 | -0.950 | 17.8 | -0.872 | 12.7 | -0.842 | 26.2 | -0.844 | 26.2 |
| Vehicle Quality | -0.477 | 7.8 | -0.190 | 1.5 | -0.452 | 7.3 | -0.598 | 7.1 | -0.462 | 12.2 | -0.459 | 12.0 |
| Constant | - | - | - | - | - | - | - | - | - | - | 0.024 | 0.7 |
| VOT-Std $/hr | 9.41 | 16.9 | 21.55 | 8.1 | 16.33 | 16.2 | 17.81 | 14.8 | 14.39 | 28.5 | 14.03 | 22.6 |
| VOT-Conc$/hr | 5.42 | 26.2 | 12.68 | 6.8 | 7.45 | 21.7 | 5.31 | 24.7 | 6.02 | 44.0 | 5.89 | 40.6 |
| VOT-Av $/hr | 7.73 | 23.2 | 20.67 | 8.5 | 13.49 | 19.4 | 15.01 | 16.1 | 11.78 | 33.7 | 11.49 | 26.8 |
| SI/IVT | 0.66 | 16.8 | 0.73 | 11.4 | 0.62 | 19.6 | 0.36 | 13.8 | 0.58 | 31.1 | 0.59 | 26.0 |
| Stop Qual/IVT | 12.4 | 10.7 | 11.4 | 7.1 | 13.7 | 14.4 | 10.7 | 11.0 | 12.6 | 21.9 | 12.8 | 19.9 |
| Veh Qual/IVT | 8.2 | 7.3 | 2.4 | 1.4 | 6.5 | 7.0 | 7.3 | 6.8 | 6.9 | 11.7 | 7.0 | 11.2 |
| Constant/IVT | - | - | - | - | - | - | - | - | - | - | -0.4 | 0.7 |
| Income $k pa | 38 | | 63 | | 44 | | 69 | | 49 | | | |
| Concession % | 42% | | 10% | | 32% | | 22% | | 31% | | | |
| SI (mins) | 22 | | 13 | | 20 | | 32 | | 22 | | | |
| Ave wait (mins) | 7 | | 6 | | 8 | | 8 | | 7 | | | |
| Av IVT (mins) | 22 | | 13 | | 37 | | 26 | | 28 | | | |
| Observations | 13,285 | | 3,598 | | 14,462 | | 8,830 | | 40,175 | | | |

# Explaining modal variation in values of time & service quality

Further analysis looked at how the value of time, service interval, and quality varied and the extent to which such variation explained the differences in values by mode presented in Section 7.

The analysis looked at a range of factors. Income and journey purpose were found to have statistically significant effects on the value of time. Gender, trip length and frequency of service also affected the sensitivity of response to the SP attributes.

After identifying the significant influencing factors, response was ‘standardised to the mean’ using a technique developed by Douglas and Jones (op cit). The residual modal differences could then be considered to be ‘intrinsic’ differences attributable to the modes themselves.

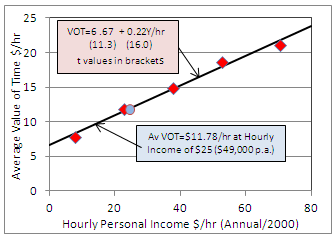
**8.1 Effect of income**

Income is an obvious factor influencing the willingness to pay to save travel time. Adopting the same ‘equity’ value of time for different transport modes has been justified on the grounds of not biasing evaluations towards transport modes used by richer passengers and away from those used by poorer passengers. By standardising for income, the effect of income can be neutralised. Table 5 and Figure 3 summarise the results.

Table 5: Effect of income on values of time & service quality

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Relative Valuation | 0-30k | 30-60k | 60-90k | 90-120k | >120k | ALL |
| VOT - Std $/hr | 10.13 | 13.76 | 15.85 | 19.87 | 22.05 | 14.39 |
| VOT - Conc $/hr | 5.56 | 6.12 | 6.05 | 6.73 | 7.11 | 6.02 |
| VOT - Av $/hr | 7.77 | 11.87 | 14.84 | 18.68 | 21.11 | 11.78 |
| SI/IVT | 0.66 | 0.63 | 0.52 | 0.49 | 0.42 | 0.58 |
| Stop Qual/IVT | 15.3 | 13.7 | 10.7 | 9.4 | 7.9 | 12.6 |
| Veh Qual/IVT | 8.1 | 8.3 | 6.6 | 3.1 | 5.4 | 6.9 |
| Concession Percent | 52% | 25% | 10% | 9% | 6% | 31% |
| Mean Income $000s/year | 15 | 45 | 75 | 105 | 140 | 49 |
| Hourly Income $/hr (/2,000 hrs) | 8 | 23 | 38 | 53 | 70 | 25 |
| Av VOT ÷ Income/hr | 104% | 53% | 40% | 36% | 30% | 48% |

Figure 3: Value of Time & Hourly Personal Income



The average value of time increased from $7.77/hr for annual incomes under $30k to $21.11/hr for incomes over $120k. The increase was approximately linear rising at 22 cents per dollar of hourly income (annual income ÷ 2,000 hours) from a predicted base of $6.67/hr. Measured at the mean, the value of time of $11.78/hr represented 48% of average hourly earnings. Given the linear function, the value of time elasticity declined with income. Measured at the mean of the data, the elasticity was 0.44 which like other cross-sectional estimates, is lower than time-series based elasticities.

By raising the sensitivity to in-vehicle time, income also had the effect of reducing the relative valuation of service interval, stop quality and vehicle quality since the sensitivity to these attributes was largely unrelated to income. For example, the value of stop quality declined from 15.3 minutes for respondents with an income of ≤$30k to 7.9 minutes for respondents with an income over $120k.

## 8.2 Journey purpose

Although, as Section 2 commented, economic evaluations have often adopted the same value of time for all trips purposes, forecasting models have often used segmented values. The Sydney Public Transport Project Model for example, which forecasts the AM peak period, has four trip purposes (journey to work, company business, education and other trips) and uses different values of time for each segment.

The sample was large enough to estimate values of time for eight trip purposes with reasonable precision as shown in Table 5. At $17.18/hr, respondents making company business trips had the highest value of time which partly reflected higher incomes which averaged $77k and low concession use. Work commuting trips, with incomes averaging $65k, had the second highest value of time $15.49/hr. The lowest values of time, averaging just over $8/hr, were for education and shopping trips which had the lowest incomes of $39k and $22k respectively.

Table 6: Values of time & service level by trip purpose

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Relative Valuations | Work | Educ | PBsn | CBsn | Shop | VFR | EntH | Oth | ALL |
| VoT Non Concession $/hr | 16.13 | 10.46 | 12.92 | 18.71 | 10.91 | 11.63 | 13.47 | 13.11 | 14.47 |
| VoT Concession $/hr | 8.62 | 6.91 | 5.09 | 6.96 | 4.07 | 5.50 | 4.79 | 5.05 | 5.96 |
| VoT - Average $/hr | 15.49 | 8.05 | 9.71 | 17.18 | 8.19 | 9.24 | 11.02 | 9.23 | 11.82 |
| Service Interval / IVT | 0.57 | 0.68 | 0.53 | 0.46 | 0.63 | 0.55 | 0.78 | 0.58 | 0.58 |
| Stop Quality mins/trip | 10.0 | 12.6 | 15.9 | 8.7 | 20.0 | 14.8 | 17.5 | 14.5 | 12.6 |
| Veh Qual mins/trip | 6.2 | 4.7 | 6.8 | 5.0 | 11.7 | 11.1 | 10.7 | 4.9 | 6.9 |
| VoT Non Conc $/hr Standardised\* | 14.03 | 12.19 | 12.21 | 15.26 | 12.64 | 11.61 | 13.96 | 12.93 | 13.57 |
| VoT Conc $/hr Standardised\* | 8.74 | 7.40 | 5.66 | 6.30 | 4.95 | 5.61 | 4.46 | 4.88 | 5.97 |
| VoT -Average$/hr Standardised\*^ | 12.38 | 10.69 | 10.16 | 12.47 | 10.24 | 9.74 | 11.00 | 10.42 | 11.20 |
| Percent Concession % | 9% | 68% | 41% | 13% | 40% | 39% | 28% | 48% | 31% |
| Mean Income $000s/year | 65 | 22 | 44 | 77 | 39 | 43 | 52 | 41 | 49 |
| SP Responses | 14,876 | 6,820 | 3,754 | 927 | 2,980 | 3,498 | 5,335 | 1,632 | 40,175 |
| Interviews | 1,893 | 868 | 478 | 118 | 379 | 445 | 679 | 208 | 5,112 |
| Pbusn Personal business, Cbusn Company Business, VFR Visiting friends & relatives, EntH entertainment/holiday | | | | | | | | | |
| \* standardised for income ^ standardized at average concession share (31%) | | | | | | | | | |

Table 6 also shows the effect of standardising for income and also of the concession share. Standardisation reduced the JTW and company business values to $14.03/hr and $15.26/hr (standard fare) since these purposes had higher than average incomes. For the other trips purposes, the value of time increased since these purposes had lower than average incomes.

Similarly, raising the concession share for JTW and company business trips to the sample average of 31%,reduced the average value of time to $12.38/hr and $12.47/hr respectively whilst raising the values for the other trip purposes that had higher concession shares. The net effect was to reduce the range in the value of time threefold from $9.14/hr ($8.05/hr Education to $17.18/hr Company Business) down to $2.73/hr ($9.74/hr Visiting Friends/Relatives to $12.47/hr Company Business). Thus income and concession share can be considered to have explained 70% of the range in the value of time leaving 30% of the range attributable to the ‘intrinsic’ nature of the different trip purposes.

## 8.3 Standardised modal models

The response to the SP was ‘standardised’ for significant factors to determine the residual or intrinsic differences by mode. Altogether eleven effects were taken into account. The approach was undertaken sequentially: income first then journey purpose (as shown in Section 8.2) followed by each of the other factors. In each step, the effects were ‘standardised to the mean’.

The effect of income (Y) affected the sensitivity to IVT and to concession fare but did not affect the sensitivity to standard fare, stop quality and station quality. Journey purpose (JP) had four significant effects. JTW and company business trips were more sensitive to service interval and to IVT than the other trip purposes. Entertainment and holiday trips were more sensitive to fare whereas JTW and education respondents who were entitled to a fare concession were less sensitive to fare.

In terms of gender (G), males were 30% more sensitive than females to concession fare whereas females were 40% more sensitive to vehicle quality. The length of waiting time (WT) affected the sensitivity to stop quality. Passengers waiting longer than 20 minutes were a quarter more sensitive to stop quality than passengers waiting less than 20 minutes.

The sensitivity to service interval increased with the frequency of the actual service the respondents was using reflecting ‘conditioning’ to actual experience. Finally, increasing trip length (TL) increased the sensitivity to vehicle quality. The standardised model is presented in Table 7.

Table 7: Estimated models & relative valuations - standardised values

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Std | Bus | | LRT | | Rail | | Ferry | | All | |
| Effects | β | |t| | β | |t| | β | |t| | β | |t| | β | |t| |
| SI | SI \*JP | -0.038 | 29.2 | -0.047 | 21.2 | -0.039 | 32.9 | -0.040 | 17.9 | -0.039 | 52.1 |
| IVT | Y \*JP | -0.059 | 20.9 | -0.072 | 15.2 | -0.070 | 27.0 | -0.069 | 24.3 | -0.068 | 46.0 |
| Fare | JP | -0.376 | 30.4 | -0.222 | 10.3 | -0.269 | 23.4 | -0.289 | 20.7 | -0.302 | 44.7 |
| Fare Conc | Y \*JP \* G | -0.322 | 12.3 | -0.158 | 3.0 | -0.222 | 7.6 | -0.512 | 16.8 | -0.359 | 23.2 |
| Stop Qual | WT | -0.723 | 12.7 | -0.917 | 8.1 | -0.957 | 17.8 | -0.861 | 12.5 | -0.854 | 26.4 |
| Veh Qual | TL \* G | -0.450 | 7.6 | -0.187 | 1.4 | -0.386 | 8.0 | -0.677 | 9.3 | -0.439 | 13.8 |
| VOT Std $/hr | - | 9.47 | 17.2 | 19.34 | 8.5 | 15.73 | 17.7 | 14.42 | 15.8 | 13.57 | 32.1 |
| VOT Conc $/hr | - | 5.10 | 24.1 | 11.31 | 6.7 | 8.61 | 15.6 | 5.20 | 23.8 | 6.20 | 39.2 |
| VOT Av $/hr^ | - | 8.11 | 24.5 | 16.83 | 8.2 | 13.51 | 21.4 | 11.54 | 16.2 | 11.27 | 38.2 |
| SI/IVT | - | 0.65 | 17.0 | 0.65 | 12.4 | 0.55 | 20.9 | 0.57 | 14.4 | 0.58 | 34.5 |
| Stop Qual/IVT | - | 12.2 | 10.9 | 12.8 | 7.1 | 13.6 | 14.9 | 12.4 | 11.1 | 12.5 | 22.9 |
| Veh Qual/IVT | - | 7.6 | 7.1 | 2.6 | 1.4 | 5.5 | 7.7 | 9.8 | 8.7 | 6.4 | 13.2 |
| Y income (standardized at mean income of $49k, JP journey purpose, G gender, WT wait time, TL trip length  ^ calculated at the average concession share of 31%. | | | | | | | | | | | |

The net effect of standardisation was to narrow the difference in the value of time between the modes but not substantially. For light rail and ferry, the values of time declined by around a fifth from $20.67 and $15.01 in the non standardised model to $16.83/hr and $11.54/hr reflecting the removal of the uplift effect of higher than average incomes ($63k and $69k versus the average of $49k) and lower concession use particularly for light rail (10% versus 31% average). For bus, the value of time increased but only by 5% from $7.73/hr to $8.11/hr. The value of time for rail was largely unaffected since income and concession usage was near the survey average ($44k versus $49k). Thus in contrast to trip purpose, standardisation only had a modest effect in reducing the range in the values of time by mode. After standardisation, the light rail value of time remained double that of bus.

In terms of service interval and quality, the most marked effect was for ferry with the service interval valuation increasing from 0.36 to 0.57 and the value of wharf quality from 10.7 to 12.4 minutes.

# Car value of time & internet panel surveys

At the time of writing, the survey of car drivers and car passengers was at pilot stage. The original intention was to use a web based survey using an internet panel. However concerns arose from the literature review about possible underestimation by internet panel (IP) based surveys. For example, a Dutch national value of time study estimated a value of time on IP response that was half that of non IP members, Significance (2012).

As a test, the rail SP was converted to an internet survey. One hundred journey-to-work rail commuters who were members of a Sydney internet panel were then surveyed. Of the 100 responses, 22 responses were considered dubious given the stations given. Of the remaining 78 respondents, the average value of time was $9.87/hr.

**Table 8: Value of time for rail commuters: internet panel versus onboard survey**

|  |  |  |  |
| --- | --- | --- | --- |
| Estimate | Onboard Self Completion (SC) | Internet Panel (IP) | IP/SC |
| Av. Value of Time $/hr | 14.23 | 9.87 | -31% |
| Percent with VOT >$12/hr^ | 61% | 38% | -38% |
| Annual Income $kpa | 60 | 78 | 30% |
| Fare Concession % | 16% | 14% | -13% |
| Number of Respondents | 709 | 74 | - |
| ^ Sample sizes were 135 onboard and 29 IP who answered the ‘pay $2 to save 10 minutes’ question since only 1 in 3 were given it. The difference in response was significant at the 95% confidence level (t=2.3). | | | |
|

The value was 31% lower than that estimated from the 709 rail commuters who completed the onboard self-completion survey and this was despite a 30% higher average income ($78k versus $60k) of the internet panel. The response to the simple time v cost trade-off (see Section 6) was also significantly lower with 38% of the Internet Panel having a value of time of at least $12/hr compared to 61% of the onboard survey (a difference that was statistically significant at the 95% confidence level)

Thus, as with the Netherlands study, the internet panel gave a lower value of time and the same reasoning is offered namely that members of the internet panel were more cost sensitive and less time sensitive than the average rail commuter. Testing of the car survey has used face to face interviews at activity centres with the questionnaire loaded onto computer tables. The most recent designs have included travel time reliability as an attribute alongside drive time and cost.[[10]](#footnote-10)

# 10. Conclusions

It has become the norm to use a single value of time for private travel in transport appraisal. In Australia, the recommended value since 1997 has been 40% of the wage rate. As at June 2013, the value of time for NSW was $15.14/hr. TfNSW has begun a program of Stated Preference (SP) market research to test the 40% assumption by surveying public transport, car drivers and passengers with a future intention to survey walking, cycling and taxi trips.

As of July 2015, only public transport users have been surveyed using a self-completion SP questionnaire handed out on buses, trains, light rail and ferries in Sydney, Newcastle and Wollongong. Altogether 5,112 passengers completed a questionnaire which provided a large database of over 40,000 SP observations.

The survey estimated values of time, service interval, vehicle quality and stop quality. The survey estimated an average value of time for public transport users of $11.78/hr, lower than the 40% hourly earnings estimate. The difference was in part attributable to the use of fare concessions which in Sydney effectively conditions passengers to buying time savings at half price. Excluding concessions, the average of time ($14.39/hr) was within 5% of the value of $15.14/hr based on 40% wage proportion.

The average value of time varied markedly by mode. The analysis looked at a range of factors that could explain the variation. The value of time was found to increase with personal income. After standardising for income and concession use, 70% of the difference by trip purpose was able to be explained but JTW and company business trips retained a higher sensitivity to in-vehicle time. Gender, trip length and frequency of service were also found to affect response sensitivity but to service interval, stop quality and vehicle quality rather than affecting the value of time. After identifying the significant factors, response was ‘standardised to the mean’ and having done this, the residual difference by mode was determined.

Standardisation did narrow the difference in the values of time by mode but not substantially. Thus there remained strong ‘intrinsic’ factors that produced a wide range in the value of time by mode after standardisation. Whether these factors are a reason for adopting the same ‘equity’ value of time for all modes remains open to debate.

At the time of writing, the survey of car drivers and car passengers was at pilot stage. One finding of note has been in terms of survey method. The original intention was to use an internet panel. As a test, the rail SP was converted to an internet survey and one hundred journey-to-work rail commuters who were members of a Sydney internet panel were surveyed. The resultant value of time was 31% lower than the onboard self completion estimate. The same reasoning as in the Netherlands study is offered namely that members of internet panels tend to be more cost sensitive and less time sensitive than average travellers. On consideration of this result, the pilot car surveys have been undertaken using face to face interviews using computer tablets.

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1. In Sydney, concession users are public transport passengers entitled to a fare discount (typically 50%) by virtue of being a student or retired. In many of the Stated Preference surveys which have been undertaken in Sydney, the concession fare (half the standard fare) was presented below the ‘standard’ fare and taken into account in the analysis of response. Usually an additional variable was included to allow for concession users to have a different sensitivity to fare as standard fare payers. The net result was for concession users to be twice as sensitive to fare as standard fare payers and which generally produced a value of time half that of standard fare users. [↑](#footnote-ref-1)
2. Advice from Dr Mark Harvey, Research Manager, Regulatory Reform and Investment Analysis, Bureau of Infrastructure, Transport and Regional Economics [↑](#footnote-ref-2)
3. The surveys have been designed by Douglas Economics in consultation with TfNSW and the field work has been undertaken by EY-Sweeney Research. [↑](#footnote-ref-3)
4. The figures exclude questionnaires that had no response to any SP question (7% overall). [↑](#footnote-ref-4)
5. With some a longer questionnaire designed for inter-city services. [↑](#footnote-ref-5)
6. The BTS 2013 surveys included an in-vehicle time multiplier SP survey which had the specific objective of determining modal preferences for bus, rail and light rail. [↑](#footnote-ref-6)
7. The NZ study looked at alternative ways of presenting quality. The five star system was considered to be the best through discussions with the surveyors and respondents. [↑](#footnote-ref-7)
8. A full factorial design (whereby all combinations of levels are included) required 3,125 experiments. [↑](#footnote-ref-8)
9. The example presents the first SP question in the booklet which included an explanation of the task and the choice. The subsequent choices only presented the choices (i.e. without the explanation). [↑](#footnote-ref-9)
10. The peer reviewer of the car survey, Professor Hensher of the Institute of Transport and Logistic Studies, University of Sydney suggested that reliability be included in the car study as well as time and cost.

    , [↑](#footnote-ref-10)