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9-1-2011

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Australasian Transport Research Forum 2011 Proceedings
28 - 30 September 2011, Adelaide, Australia
Publication website: http://www.patrec.org/atrf.aspx

Tracking the value of rail time over time

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Abstract

The value of rail time is an important economic parameter in the evaluation of many rail infrastructure projects, translating travel time savings into dollars to compare against project costs.

For Sydney, the value of onboard train travel time has been estimated through Stated Preference market research. Three surveys have been undertaken over the last two decades. The first was undertaken in 1992; the second in 2003 and the third in 2010. Between 1992 and 2010, the value of time has been updated by reference to movements in fare and latterly by reference to wage rate indices.

This paper describes the features of the three surveys and the values of time obtained and compares the values with other study estimates usually obtained as 'by-products' of patronage studies.

The study looks at six alternative indices to update values of time and reviews the approaches used overseas. The alternative indices are then compared against the growth in the estimated values of time for Sydney. A composite index of the NSW wage index and the Consumer Price Index weighted in accordance with the share of employed and non-employed passengers produced the closest fit.

1. Introduction

The value of rail time is an important economic parameter in the evaluation of many rail infrastructure projects. The CityRail Compendium provides statistics on the Sydney rail system and one statistic that has been included in all seven editions of the Compendium to date is the value of onboard train time (CityRail, 1995-2010). The first edition of the Compendium in 1996 reported an average value of time of $4.70 per hour. The seventh edition, dated June 2010, reports an average value of $11.90 per hour. Figure 1 and Table 1 presents the values given in the seven editions of the Compendium.

The Compendium values have been based on market research surveys. The first survey was undertaken in 1992. A second survey was undertaken fourteen years later in 2004 and a third in 2010. Figure 1 presents the average values of time and the confidence range surrounding the estimates. The three studies are reviewed in sections 2-4.

There have also been several major public transport patronage studies that have produced values of time usually as 'by-products' or 'sensibility checks'. Section 5 reviews the values and compares them with the CityRail estimates.

Figure 1: Trend in the Value of Sydney Rail Time

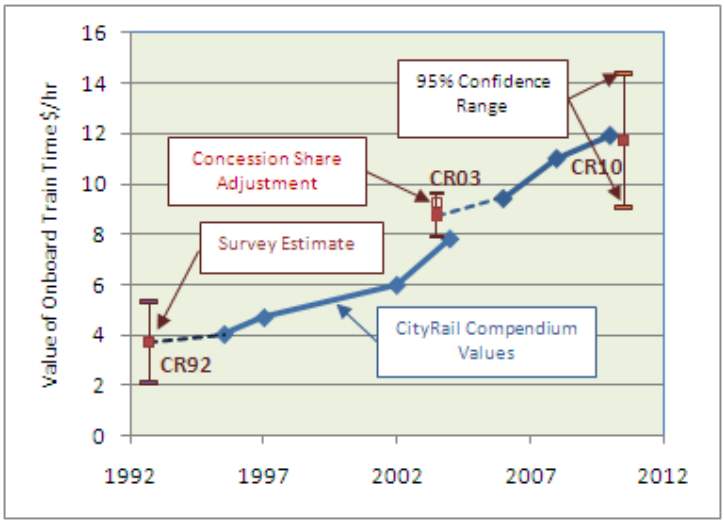


Table 1: CityRail Compendium Values of time $/hr

Compendium		Value of Time
Edition	Year	$/hr
1	1995	4.03
2	1996-97	4.70
3	2001-2002	6.00
4	2003-2004	7.85
5	2005-06	9.44
6	2007-08	11.00
7	2009-10	11.90

Source: CityRail Compendium

Between the 1992 and 2003 surveys, the values of time have been updated using indices. The first edition of the Compendium used the change in fare to 'update' the 1992 survey estimate. Latterly, the wage index for New South Wales (NSW) has been used. There are in fact several alternative indices that could have been used. Section 6 describes six alternatives. Section 7 then discusses overseas practice and shows that earnings indices have tended to be favoured over consumer price indices or GDP deflators. Elasticities have also been applied to produce less than proportional increases in the value of time.

Section 8 looks at how the alternative have performed in tracking the increase in the value of time estimated by the 2004 and 2010 CityRail surveys. The analysis finds that a composite index comprising the NSW wage index and the consumer price index weighted in accordance to the percentage of employed and non-employed rail passengers gave the closest fit.

2. 1992 CityRail survey

SDG/GHD-Transmark was commissioned in 1992 by the State Rail Authority (SRA) to estimate a set of fare demand elasticities (SDG-Transmark, 1993). The values of time presented in the report were provided as a test of reasonableness rather than as a primary study output.

A total of 1,177 rail passengers across the rail network were interviewed. The sample was split into short, medium and long trips. However peak and off-peak travel was not distinguished. Passengers were presented with a set of pair wise travel choices. In fact, three sets of travel choices were developed. One set compared travelling by rail with travelling by car, another set compared rail with bus and the third set compared rail with walking. The set that passengers completed depended on how they said they would have travelled had rail been unavailable. In each choice, passengers were asked to decide whether they would use rail or the alternative mode (car, bus or walk) given the times and costs shown for the trip they were making (e.g. travelling to work).

The individual responses were analysed by maximum likelihood to explain the probability of choosing rail in terms of fare, cost and travel time. By comparing the estimated fare and onboard train time parameters, the values of time presented in Table 2 were derived. The

most precise values were $3.36 per hour for medium length trips with car as the alternative and for short distance trips with bus as the alternative ($3.61 per hour). The other estimates had wide confidence intervals.

Table 2: 1992 CityRail survey values of rail time
Value of onboard train $/hr by alternative travel mode (1992 dollars)

	Car			Bus			Walk
	Short	Medium	Long	Short	Medium	Long	Short
Value of Rail Time $/hr	17.11	3.36	8.24	3.61	4.24	w.s.	0.22
95% Confidence Range ± $/hr	27.48	1.76	6.07	1.65	3.01	na	8.27

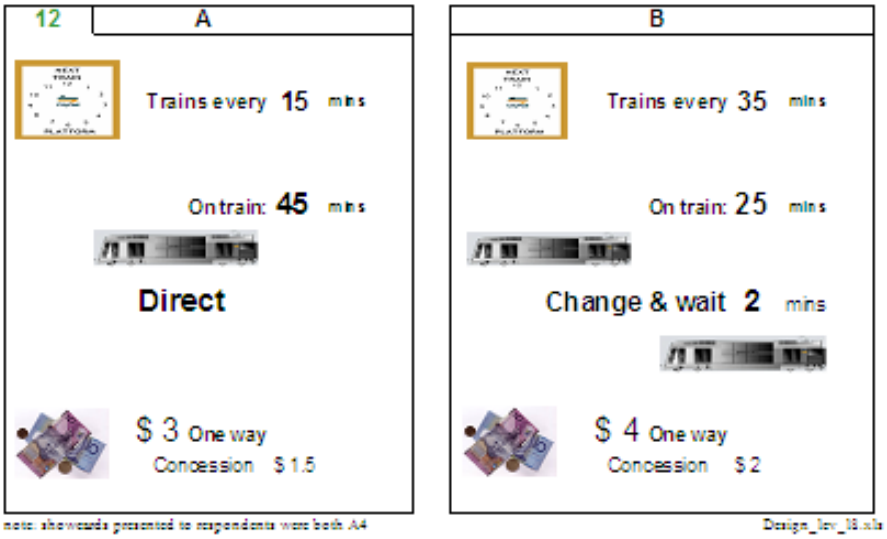
An overall value of time was not tabulated but the report stated that *"the most reliable estimate of the value of rail in-vehicle was $3.70 per hour"*.[1] The first CityRail Compendium which was published in 1995 updated the SDG-GHD-Transmark study by taking into account the change in rail fare. A value of time of $4.05 per hour was reported.

3. 2003 CityRail survey

The 2003 survey was designed and analysed by Douglas Economics. Stated Preference market research was used but unlike the 1992 study, the study aimed to estimate values of time rather than demand elasticities. Accordingly, the survey focused exclusively on rail and did not make any reference to travelling by car, bus or walking.

The questionnaire asked rail passengers to choose between two rail services that varied in terms of fare, onboard train time, service interval (the number of minutes between successive services) and transfer (whether the passenger would have to change trains and how long the wait would be). Pictograms were used to present the choices. Figure 2 presents an example choice.

Figure 2: 2003 CityRail Survey - Stated Preference Example



[1] The figure of $3.70 appears to be a weighted average of the car medium and bus medium values weighted by their SBA shares (59% car and 41% bus). A standard error for 'the most reliable value' was not reported but a figure of ±$0.82 and a 95% confidence interval of ±$1.60 was calculated using the reported confidence intervals.

The experimental design was based on sixteen pair wise choices although each respondent only completed a maximum of eight choices. The design was specified in terms of the difference in fare and travel time between the two train services. To tailor the choices to the passenger, six trip length categories were defined so that the fares and travel times could be closely matched to the each passenger.

A total of 1,578 surveys were undertaken in April - June 2003 over the Sydney rail system. Surveys were undertaken on Saturdays as well as weekdays. Passengers travelling free (such as CityRail employees) and younger school–children were screened out. The fares for passengers entitled to a concession were set at half the standard fare.

Table 3 presents the 'final' values of time by market segment. The 'all' values in the right hand column are weighted averages of the short, medium and long trip estimates using CityRail ticket sales data. Non concession passengers had a value of time of $10.36 per hour which was roughly twice that of non concession passengers who valued time at $5.13 per hour.

Table 3: 2003 CityRail Survey values of rail time
Value of onboard train $/hr (2003 Dollars estimates include GST)

	Peak				Off-Peak				ALL
	Short ≤25mins	Med 26-40	Long > 40	ALL	Short ≤25mins	Med 26-40	Long > 40	ALL	
CityRail Trip Share %	30%	11%	16%	57%	23%	8%	12%	43%	100%
Sample Concession %	15%	25%	31%	22%	35%	44%	51%	41%	30%
CityRail Concession %	19%	19%	19%	19%	25%	25%	25%	25%	21%
Non Concession VOT $/hr	10.23	10.66	11.47	10.66	10.24	10.66	11.46	9.96	10.36
Concession VOT $/hr	5.56	5.36	5.08	5.39	1.94	5.39	5.08	4.80	5.13
Av. VOT $/hr (Sample Conc %)	9.52	9.35	9.48	9.46	7.31	9.46	8.20	7.83	8.76
Standard Error VOT $/hr	1.28	1.77	1.35	0.84	1.27	1.03	1.07	0.62	0.43
Av. VOT $/hr (CityRail Conc %)	9.34	9.65	10.26	9.66	8.17	9.34	9.87	8.67	9.26

The average value of time of $8.76 per hour was a weighted average of the concession and non concession values. The weights were based on the proportion of passengers interviewed who were entitled to a concession. The sample share was higher than the concession share of ticket sales however. If RailCorp ticket sales had been used to estimate the concession share (the bottom row in Table 3) the average value of time would have been $9.26 per hour. In Figure 1 the unadjusted and adjusted average values of time are shown.[2]

4. 2010 CityRail survey

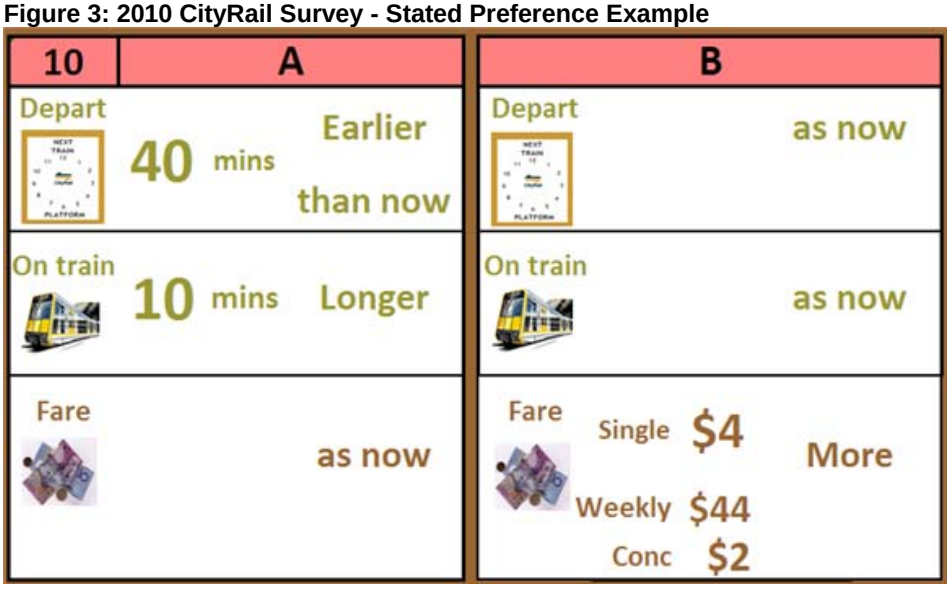
The 2010 survey, like the previous 2003 survey had the specific aim of estimating values of onboard train time and was designed and analysed by Douglas Economics. Interviewers presented passengers with a series of pair wise choices of train services. The train services varied in terms of the departure time, time spent on the train and the fare. Figure 3 presents an example.

An experimental design of fifty choices was developed with respondents completing up to nine choices each. The design specified five levels for onboard train time and fare and ten levels for departure time. The times and fares were specified as changes on the current

[2] The adjusted value ('concession share adjustment') is shown as the unshaded square.

trip. Two of the five levels for onboard train featured an increase (for train B), two levels involved a decrease and in the fifth level there was no change in onboard train time. For fare, three levels featured an increase (or surcharge) in fare for train A and two levels a decrease (discount) for train B. Five of the ten displacement levels featured later departures than now for train B and five levels featured earlier departures for train B. Travel time displacement is discussed in more detail in Douglas, Henn and Sloan (2011).

Figure 3: 2010 CityRail Survey - Stated Preference Example



The survey interviewed 1,119 passengers of which 786 (70% of the total) were travelling in the peak and 333 in the off-peak. All the surveys were undertaken on weekdays. Half the passengers were making medium length trips of 26-40 minutes; just under 30% were making short trips (<26 minutes) and one fifth were making long trips (> 40 minutes). The surveys were undertaken on suburban services. Intercity services were not surveyed. Young school children were not interviewed.

A variety of models were fitted to the data. Table 4 presents the values of time of the preferred model.

Table 4: 2010 CityRail survey values of rail time
Value of onboard train $/hr (2010 dollars estimates include GST)

	Peak				Off-Peak				ALL
	Short ≤ 25mins	Med 26-40	Long > 40	ALL	Short ≤ 25mins	Med 26-40	Long > 40	ALL	
CityRail Trip Share %	30%	11%	16%	57%	23%	8%	12%	43%	100%
CityRail Concession %	19%	19%	19%	19%	25%	25%	25%	25%	21%
Non Concession VOT $/hr	12.90	11.94	18.70	14.34	11.82	14.20	9.92	11.74	13.22
Standard Error VOT $/hr	2.52	1.65	5.46	2.05	4.43	4.67	5.79	2.26	1.20
Concession VOT $/hr	-	-	-	-	-	-	-	-	6.03
Standard Error VOT $/hr	-	-	-	-	-	-	-	-	1.70
Av. VOT $/hr ^	11.60	10.82	16.29	11.86	10.38	12.16	8.95	10.05	11.71
Standard Error VOT $/hr	2.07	1.37	4.44	1.20	3.35	3.53	4.37	1.98	1.36

Notes: ^ weighted average of concession and non concession values

Values for non concession passengers were estimated by market segment and had relatively low sampling error. The peak value was $14.34, the off-peak $11.74 and the

weighted average was $13.22 per hour. It was not possible to estimate reliable market segment values of time for concession passengers however so an overall value of $6.03 per hour was used. The concession and non concession values were then weighted according to CityRail ticket sales data to give an average value of time of $11.71 per hour.

5. Review of other studies

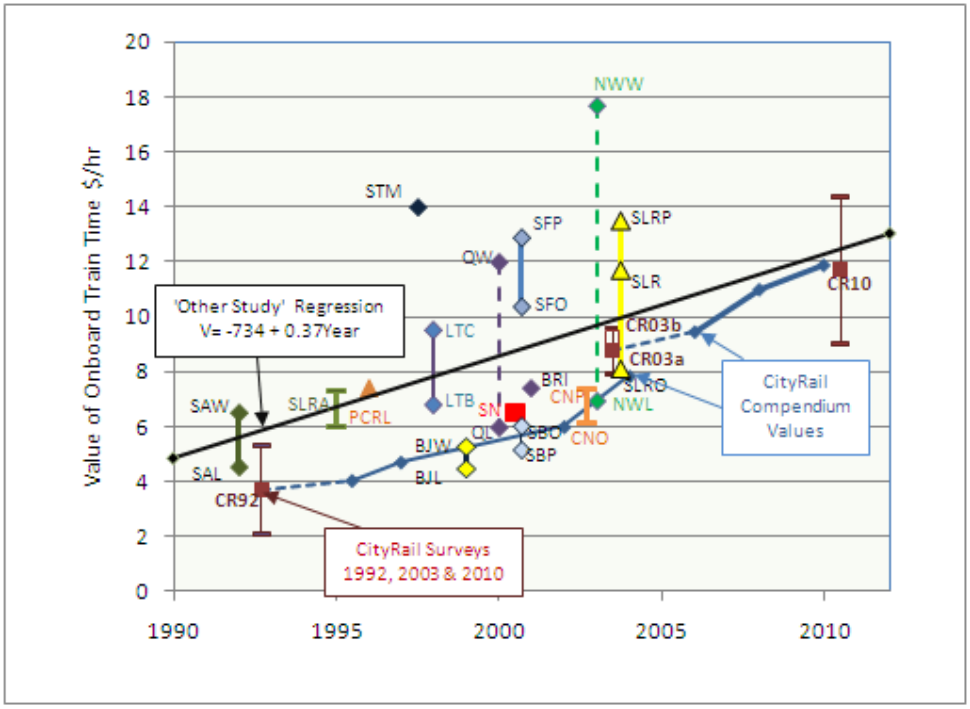
The values of time were compared with other studies undertaken in New South Wales, Queensland and Canberra between 1992 and 2004. Most of the values of time were for rail travel although some values were obtained for ferry and bus travel. A summary is presented in Table 5.

Table 5: Review of value of time estimates
Value of in-vehicle time in dollars per hour (Nominal Prices)

Subject	Study	Year	Code	Value $/hr	Comment
CityRail	SDG/GHDHalcrow	1992.7	CR92	3.70	Market research of rail passengers to estimate elasticities. Overall average.
" " "	Douglas Economics	2003.5	CR03a	8.76	Large scale SP market research of rai passengers to estimate values of time. Overall average figure with concession value weighted by survey percent.
" " "	" " "	2003.5	CR03b	9.37	As above but with concession value weighted by CityRail percent.
" " "	Douglas Economics	2010.5	CR10	11.71	Current study. SP market research of rail passengers. Overall value using CityRail concession and market segment weights.
Sydney Airport Link	DJA	1992	SALW	6.50	SP market research to forecast patronage on Sydney Airport Rail Link. Value for work commuting trips to airport and surrounding area.
" " "	" " "	1992	SALL	4.50	As above but value for leisure (i.e. non business) trips to airport.
SLRA	BAH - PCIE	1995	SLR	6 to 7.30	SP market research to forecast patronage for extending Sydney Light Rail.
Sydney Travel Model	Hague Consulting	1997-8	STMW	14.00	Value reported in calibration report of Sydney Travel Model. Model based on Household Travel Survey data for travel to work.
Parramatta-Chatswood	PPK	1996	PCRL	7.40	SP market research or rail, bus and car users to forecast patronage of Parramatta - Rail Link.
Liverpool Transitway	PPK	1998	LTWCA	9.50	SP market research of rail passengers (using car to access station) to forecast patronage of Liverpool-Parramatta Transitway.
" " "	PPK	1998	LTWBA	6.80	As above but of rail passengers using bus to access station.
Bondi Junction	Halcrow	1999	BJW	5.25	Market research of rail commuters to forecast patronage of ESR-Bondi beach extension
" " "	" " "	1999	BJL	4.44	As above but of rail passengers making leisure trips.
S.E. Queensland	PCIE	2000	SEQW	12.00	SP market research of longer distance rail passengers on radial routes to Brisbane. Work trips.
" " "	PCIE	2000	SEQL	6.00	As above but leisure trips
Sydney Newcastle	PCIE-BNR	2000.5	SN	6.50	SP market research of rail passengers to forecast demand for rail improvements on Sydney - Newcastle.
Sydney Ferries	BAH-DE	2000.7	SFP	12.84	Market research of Sydney ferry users to forecast demand impacts of service improvements. Weighted concession/non concession ferry peak value.
" " "	" " "	" " "	SFO	10.35	As above but for off-peak ferry passengers.
" " "	" " "	" " "	SBP	5.16	As above but for peak bus passengers.
" " "	" " "	" " "	SBO	6.04	As above but for off-peak bus passengers.
Brisbane	BAH - DE	2001	BRI	7.40	SP market research or rail, bus, car and ferry users to estimate elasticities.
North West Rail Link	ITS	2003	NWW	17.70	SP market research of rail, car and bus users to forecast patronage for a North West Transport Link. Value for Commuting to work.
" " "	" " "	" " "	NWL	6.90	As above but for leisure trips.
Canberra	BAH-DE	2002	CNP	7.30	SP market research to estimate elasticities. Overall value of peak bus travel. $11.30 work; $7.90 educ-uni; $3.20 educ-sch; $7.20 other.
" " "	" " "	" " "	CNO	6.10	As above but trip weighted average for the Off-Peak
SLR	BAH - DE	2003.75	SLR	11.70	SP research to forecast demand for Sydney Light Rail extension. Overall value was $11.70/hr with $13.50/hr peak &$8.10/hr off-peak. Concession and non concession passengers were distinguished and trip weighted. Non concession value was 40% higher than concession value.
" " "	" " "	" " "	SLRP	13.50	
" " "	" " "	" " "	SLPO	8.10	

Figure 4 presents the values of time against the year of estimate and shows a general increase in the value of time over time.

Figure 4: Values of time over time
Value of onboard train time $/hr



Notes: See Table 5 for codes

Deriving a value of time was not the primary objective of most studies. Rather, the values of time were 'by products' produced either as part of deriving demand parameters to use in a forecasting model or as sensibility checks on the market research results.

The earliest study reviewed was a 1992 patronage forecast for a Sydney airport rail link. The study was undertaken by Denis Johnston & Associates and used Stated Preference questionnaires similar to the 1992 SDG study (Denis Johnstone and Associates, 1992). A value of rail travel time of $6.50 per hour was estimated for commuters and $4.50 per hour for leisure trips. Also estimated but omitted from Figure 4 because of its exceptional nature was a value of $27.10 per hour for business travellers accessing Sydney airport.

In 1995, as part of forecasting demand for a Light Rail extension to Sydney CBD, Booz Allen Hamilton and PCIE estimated value of times of $6 to $7.30 per hour for single ticket users (Booz Allen, 1995).

In 1996, Stated Preference surveys undertaken by RPPK and PCIE as part of producing patronage forecasts for the proposed Parramatta-Chatswood rail line patronage estimated a value of onboard train time of $7.40 per hour (RPPK and PCIE, 1996).

Using 1997/8 Household Travel Data for car, bus and rail, Hague Consulting estimated a mode choice model for the Sydney Travel Model (Hague, 2001). In the calibration report Hague Consulting reported an average value of time of $14 per hour for commuting to work by rail, $12 for car and just over $10 for bus.

In 1998, as part of forecasting patronage for the Liverpool –Hoxton Park Transitway, PPK estimated a value of onboard time ranging from $6.80 for passengers accessing by bus to $9.50 per hour for passengers accessing by car were estimated based on 750 interviews of rail passengers (PPK, 1998).

In 1999, as part of forecasting the demand for a proposed extension of the Eastern Suburbs Rail line to Bondi Beach, Halcrow undertook Stated Preference market research of rail passengers and estimated a value of onboard train time of $5.25 per hour for rail commuters and $4.44 for leisure trips (Halcrow, 1999).

In 2000, as part of forecasting the patronage and economics of upgrading the Sydney - Newcastle rail line, PCIE and BNR Consulting estimated a value of $6.50 per hour based on 255 Stated Preference surveys (PCIE-BNR, 2000).

Also in 2000, as part of developing a business plan for Sydney Ferries, Booz Allen Hamilton and Douglas Economics surveyed 810 ferry and bus passengers using Stated Preference questionnaires (BAH and DE, 2001). Values were estimated for concession and non concession passengers and then trip weighted. Ferry passengers had a peak value of time of $12.84 and an off-peak value of $10.35 per hour. Bus users had a peak value of $5.16 and an off-peak value of $6.04 per hour.

In 2003, as part of the study of evaluating transport options for a proposed North West Transport Link, the Institute for Transport Studies Sydney undertook Stated Preference market research of rail, bus and car users in the North West sector of Sydney and estimated a value of time of $17.70 per hour for journey to work trips and $6.90 per hour for 'other' trips.

Also in 2003, Booz Allen Hamilton and Douglas Economics undertook market research as part of a patronage forecast for extending the light rail system in Sydney (BAH and Douglas Economics, 2003). 250 Light Rail and bus passengers were interviewed using Stated Preference surveys. The average value of time was $11.70 per hour with a peak value of $13.50 and an off-peak value of $8.10 per hour. Concession passengers valued time 70% as highly as non concession passengers.

Two studies from Brisbane were also reviewed. In 2000, PCIE and Ove Arup estimated a value of time for longer distance rail trips to Brisbane of over 45 minutes of $12 per hour for work-commuters and $6 per hour for non work, mainly leisure trips (PCIE and Ove Arup, 2000).

In 2000-01, Booz Allen Hamilton and Douglas Economics undertook a large scale Stated Preference survey of bus, ferry and car users in Brisbane. The study involved over 4,000 surveys and the study estimated an average value of onboard train time of $7.40 per hour with a peak value of $8.10 and an off-peak value of $7.40 (Douglas, Franzman and Frost, 2003).

In 2003, Booz Allen Hamilton and Douglas Economics undertook Stated Preference market research to estimate public transport service elasticities for Canberra, (BAH and Douglas Economics, 2003). The study derived a peak value of time for bus of $7.30 and an off-peak value of $6.10 per hour based on trip weighted journey purpose estimates of $11.30 for commuting to work, $7.90 for education (university) trips, $3.20 education trips and $7.20 per hour for other trips.

In all, 25 'other study' observations of the value of time were obtained. To assess, the extent of any trend in the values over time, a simple linear model was fitted. Equation 1 presents the fitted model with standard errors in parenthesis:

Value of Time ($/hr) =	-734	+	0.37 (Year)	.....(1)
	(387)		(0.19)	

The model quantified the upward trend in the value of time at 37 cents per year. Given the linear form, the percentage change reduced each year. Measured from 2010, the predicted annual increase was 3%.

The 'model' is admittedly simple and no attempt was made to perform a 'meta' analysis by taking account of the nature of the travel time (purpose, time period and mode) and introducing explanatory economic variables (see for example Abrantes, 2009). However the analysis did help assess the CityRail Survey and Compendium values. As can be seen from Figure 4, the values in the early editions of Compendium which were based on the 1992 survey are below the trend line and towards the bottom of the range of estimates. Then after the 2004 CityRail survey, the Compendium values converge towards the 'other study' trend line.

It should also be remembered that the CityRail values are 'overall' figures and should tend to be lower than 'peak only' estimates such as the $12.84 per hour Sydney Ferry value and 'work commuting' estimates such as the Sydney Travel Model $14 per hour value. Moreover, several studies did not allow for fare concession entitlement amongst students, pensioners etc which reduced the overall values in the 2003 and 2010 CityRail surveys.

6. Alternative update indices

Estimating the value of time every year by market research survey would be resource consuming. Over the nineteen year period 1992-2011, RailCorp has undertaken three surveys. Between the surveys, RailCorp has used economic indices to update the value of time reported in the Compendium. In this section, six alternative indices which could be used to update values of time are presented:

1. Consumer Price Index (CPI)
2. Average Hourly Earnings
3. NSW Wage Index
4. Gross State Product per Capita (GSP/C)
5. Australia Non Farm GDP Deflator
6. Average CityRail Revenue per Trip

The consumer price index (CPI) is an oft cited measure of inflation. The CPI records how the price of a bundle of consumer goods and services change over time. For Sydney and other metropolitan cities, the Australia Bureau of Statistics (ABS) compiles a CPI on a quarterly basis. The Bureau of Transport Statistics (BTS) NSW has used the CPI for Sydney to deflate the fares and cost items in the Sydney Travel Model (STM). Given that the time parameters in the STM remain unchanged, the BTS updates the values of time implicit in the model by the CPI.

The ABS estimates average hourly earnings by a survey of public and private sector employers. Figures are provided quarterly by state. The statistic represents average gross (before tax) earnings of employees and includes overtime. The figure is calculated by dividing weekly total earnings (wage plus salaries) by the number of people employed. Average total earnings are then divided by the average hours worked including overtime. Full time (≥35 hours per week) and part time employees are included in the estimate. Fosgerau considered that after-tax income should be used to update values of time rather than gross earnings and noted that when tax rates rise progressively with income, the value

of time should increase less than proportionally than the increase in gross income (Fosgerau, 2005).

The wage index derives from the ABS hourly earnings estimate. The index commenced in June 1998 and is updated annually. For the purposes of this study, the index was extrapolated back to 1992 using average hour earnings. There should be little difference in the movement in average hourly earnings and the NSW wage index over time.

Gross State Product (GSP) per capita is a ratio of two statistics: GSP and population. GSP is calculated by allocating Australian Gross Domestic Product (GDP) to States. The ABS calculates GDP using the average of three approaches: income, expenditure or production.[3] GSP per capita is derived by dividing GSP by population. Population is based on a five year Census. In regards the value of time, growth in GDP usually translates into growth in after-tax personal income. However for such proportionality, all components of GDP (personal consumption, public consumption, investment and the balance of trade) and also population need to grow at the same rate. GSP is often used to create an index deflator in order to convert nominal prices into 'real' prices. As an example, Douglas and Karpouzis used GSP to convert nominal average rail fares into real fares in an econometric analysis of the demand function for rail travel in NSW (Douglas and Karpouzis, 2009).

The Australian Non Farm GDP deflator is an index used to convert nominal GDP into real GDP thereby allowing for changes in the prices of products. It is similar to the CPI but whereas the CPI relates to prices of goods and services consumed in Australia, the GDP deflator relates to the price of goods and services produced in Australia. The indices will be similar but will diverge when the price of imported goods and services rise faster (or slower) than goods produced in Australia. The non-farm index excludes farm product prices and therefore, in principal, relates more to metropolitan areas. The index is produced quarterly but there is no index for NSW or capital cities.

The CityRail Compendium provides data to estimate of the average ticket revenue per passenger trip.[4] The average fare paid is relevant in updating values of time since most surveys use fare to measure the willingness to pay to save time. In recent years, RailCorp has made submissions to the Independent Pricing and Regulatory Tribunal (IPART) of NSW to raise fares and the tendency has been for rail fares to be increased in line with the CPI. Therefore there has been a strong correlation between movements in fare and the CPI. As well as reflecting changes in price however, movements in average revenue may also reflect changes in ticketing products, fare conditions, trip length and passenger profile for which the association with the value of time is less clear. For example, the 7th Edition of the Compendium reported a 7.4% drop in fare based on May 2010 sales data from the switch to zonal fares (MyZone).

[3] The income approach adds employee compensation, gross operating surplus, gross mixed income and taxes less subsidies on production and imports. The expenditure approach sums all final expenditures, changes in inventories and exports of goods and services less imports of goods and services. The production approach uses the sum of gross value added for each industry at basic prices plus taxes less subsidies on production.

[4] The first six editions reported the average revenue per trip. For example the 6th edition (2008) reported an average fare of $1.91 (excluding GST) based on revenue of $549.9 million and 288.5 million journeys (including unremunerative trips). The 7th Edition (2010) did not report an average fare put provided ticket data to compute a statistic. Also presented (in section 6) was the 'percentage increase in ticket prices impacting revenue'.

7. Overseas practice

In the UK at the end of the 1960s, a decision was made for all publicly funded projects to use a single standard value for non-working travel time based on *"the average income of travellers on the journey to work and is updated using the growth in disposable income per head of the population"*, (Nichols, 1975). Based on work by the Ministry of Transport, the standard value of time was set at one quarter of the average gross wage rate and was assumed to grow proportionately with income. Appropriate corrections were recommended (MAU Note 179, p 25) to convert to household income such that the value of adult travel time was set at 19% of gross household income (assuming 2,000 hours per working year). In 1987, the Department of Transport increased the standard value by 58% to 43% of the average hourly earnings of full time adult employees and updated the value in proportion to the change in real income, (UKDoT, 1987).

Other countries have also tended to update values of time in proportion to real income. World Bank guidelines note that a proportional relationship between the value of time savings and real GDP is made in many countries, (Gwilliam, 1997).

The US Department of Transportation recommended in 1997 that *"values of time are updated to reflect increases in hourly earnings throughout the nation's economy ... and analysts should not update using economy-wide measures of general price inflation such as the consumer price index or the GDP deflator", (*US DOT, 1997).

In Sweden, the growth in real GDP has been used to update values of time although not over the evaluation period of a Cost Benefit Appraisal (Fosgerau, op cit).

In the UK, updating values of time in proportion to real income lasted until 2004 when an elasticity of 0.8 was introduced meaning that a 10% increase in real income would give rise to an 8% increase in the value of time.

Empirical studies have tended to support a less than proportional response. Wardman for example estimated an income elasticity of 0.6 based on cross-sectional UK data for (Wardman, 2001a) and a GDP elasticity of 0.5 (Wardman, 2001b). For Denmark, an income elasticity of 0.63 has been estimated using before-tax income and 0.79 using after-tax income (Fosgerau, op cit).

8. CityRail survey values of time & 'update' indices

The three CityRail survey estimates of the value of Sydney rail time in 1992, 2003[5] and 2010 are presented in Table 6. Beneath the estimates is information on the six alternative update indices.

In the two bottom rows of the table, the value of time is divided by hourly earnings or hourly GSP per capita.[6] As can be seen, the value of time expressed as a percentage of hourly earnings is lower than when expressed as a percentage of hourly GSP per capita which simply reflects the higher earnings measure.

[5] The 2003 figure was weighted in accordance with CityRail concession usage.

[6] Hourly GST per capita (after tax) was calculated by dividing annual GSP by 2,000 working hours per year (US and UK DoT assumptions) which gave hourly post tax incomes of $12.60, $21.40 and $28.16 for the three years.

Table 6: Value of rail time & 'update' statistics

Year	1992.7	2003.5	2010.5
CityRail Value of Onboard Train Time $/hr	3.70	9.26	11.71
1 Consumer Price Index (cpi)	107.9	142.8	173.3
2 Average Hourly Gross Earnings ($/hr)	16.82	24.29	32.44
3 NSW Wage Index^	55.3	79.9	103.2
4 Gross State Product per Capita $*	25,200	42,800	56,325
5 Aus Non Farm GDP Deflator	0.621	0.769	1.049
6 Average CityRail Revenue ($/trip)	1.20	1.96	2.36
Value of Time / Av Hourly Earnings %	22%	38%	36%
Value of Time / Av Hourly GSP/Capita %	29%	43%	42%

^ NSW Wage Index for 1992 extrapolated based on average hourly earnings.

* Hourly GSP/Capita = GSP/capita ÷ 2,000 hours

At 22% of average hourly earnings, the 1992 value of time is comparable to the 25% share adopted in the UK until 1987 but it is noticeably lower than the shares of 38% in 2007 and 36% in 2010. These two later estimates are closer to the recommended share of 40% for personal travel trips by public transport in the US (Miller, 1996) and 43% of full time adult employee earnings for non working time adopted by the UK Department of Transport from 1987 (UKDoT, op cit). The 2007 and 2010 estimates are higher however than the 30% of average hourly wages estimated for public transport travel time in Switzerland (Axhausen, 2004).

Figure 4 and Table 6 suggest that the 1992 CityRail survey estimate was too low. The 1992 estimate was therefore omitted in assessing the accuracy of the six alternative indices in tracking the value of time.

Figure 5 compares the annual compound growth rates in the alternative update indices with the annual growth in the value of time between the 2003 and 2010 surveys.

Table 7 calculates the 'elasticity' (E) of the percentage change in the value of time ($\%\Delta VoT$) to the respective index ($\%\Delta Index$) as shown in equation 2. Only if the value of the elasticity (E) is one would the change in the value of time equal the change in the update index. If the elasticity is less than 1, the value of time would change less than proportionately with the update index and if greater than 1, the value of time would change more than proportionately.

$$E = \frac{\%\Delta VoT}{\%\Delta INDEX} \quad .....(2)$$

Over the seven year period, the value of rail time increased at an annual rate of 3.4% p.a. The increase was therefore above the rate of consumer price inflation which averaged 2.8% and was also above the increase in CityRail revenue per trip which averaged 3.1% p.a. For these two indices, the value of time elasticity was therefore greater than 1 implying that if used for updating, the value of time would need to increase more than proportionally. For the CPI, the elasticity was 1.22 (3.4%/2.8%). Therefore, if the CPI increased by 10%, the value of time would be 'updated' by 12.2%.

Figure 5: Change in value of time & update statistics
2003-2010 annual average compound percentage change

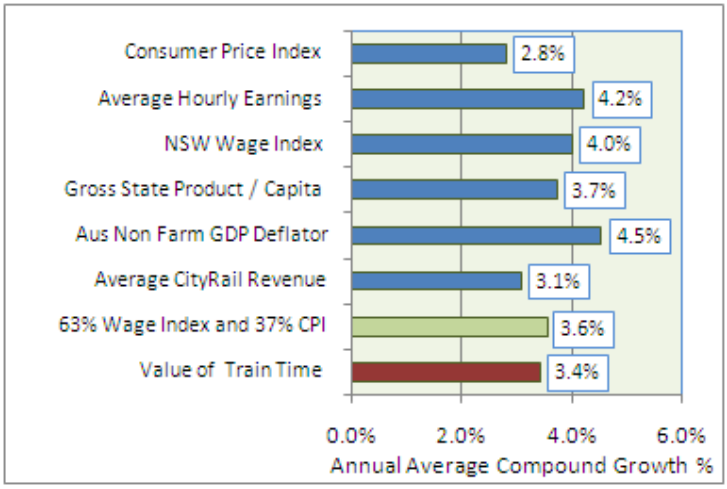


Table 7: Value of time update elasticity
% Change valued of time ÷ % Change in index

Index	Elasticity
Consumer Price Index	1.22
Average Hourly Earnings	0.81
NSW Wage Index	0.85
GSP/Capita	0.92
Aus Non Farm GDP Deflator	0.75
Average CityRail Revenue	1.27
63% Wage Index and 37% CPI	0.96

By contrast, the value of time increased less than average hourly earnings, NSW wage index, GSP per capita index and the non-farm GDP deflator. The increase for these indices and therefore the closest to the value of time increase was a 3.7% annual increase in GSP/capita. Second lowest was the wage index which averaged 4% then average hourly earnings at 4.2% p.a. The non-farm GDP deflator increased the most averaging 4.5% p.a.

The elasticities for these four indices were therefore one implying a less than proportionate increase in the value of time which is finding that agrees with the empirical studies reviewed in section 7. At 0.92, the GSP/capita elasticity was closest to unity and implies that a 10% increase in GSP/capita is associated with a 9.2% increase in the value of rail time.

An alternative to using a single index is to construct a composite index. One candidate is an index comprising the NSW wage and CPI indices. CityRail surveys estimate that 63% of rail trips are made by passengers who are employed (full or part-time) and 37% by non-employed passengers (pensioners, school children, unemployed, house persons). It would seem reasonable to apply the wage rate index to employed passengers and the CPI to non-employed passengers since pensions and unemployment benefit tend to be inflation indexed. With a 63:37 weighting, a composite wage/CPI index would have increased by 3.6% p.a. over the 2003-10 period; an increase that nearly matches the 3.4% increase in the value of time. To obtain an exact fit would require multiplying the index by an elasticity of 0.96.

It is noted that the analysis assesses the ability of the alternative update indices to 'track' just two data points. Moreover, the sampling error surrounding the two data points further tempers the statistical confidence in the conclusions drawn.

It is also worth stating that the study, although covering a reasonable time span, was undertaken during a period of relative price and wage stability unlike, for example, the 1970s.

10. Conclusions

The value of rail time is an important economic parameter in the evaluation of many rail infrastructure projects, translating travel time savings into dollars to compare against project costs. For Sydney, values of time have been estimated by three system-wide surveys of rail passengers in 1992, 2003 and 2010. Between the surveys, economic indices have been used to update the values.

The 2003 and 2010 surveys were designed specifically to estimate values of rail travel. Rail passengers travelling across the metropolitan network during the peak and off-peak were interviewed. Values of time were estimated by trip length, travel period and fare concession entitlement. The average trip weighted value of time was $9.26 per hour in 2003 and $11.71 per hour in 2010. When compared with wage rate data for NSW, both values were around 40% of the hourly wage which accorded with UK and US recommendations.

By contrast, the aim of the 1992 survey was not to estimate values of time but to estimate demand elasticities. Accordingly, the questionnaire explored the willingness of passengers to switch between rail, car, bus and walking and covered a range of costs and times rather than just rail times and fares. At $3.70 per hour, the estimated average value of rail time was low at around one fifth of the hourly wage. A recommendation that emerges out of comparing the 1992 survey with the 2003 and 2010 surveys is that market research should be specifically designed to estimate values of time rather than as a study by-product.

The three survey estimates were compared with the values estimated by a selection of other studies undertaken in NSW, Queensland and Canberra. Again most of the other study estimates were 'by – products' of demand forecasting studies and were not intended to be network comprehensive. Although a wide range in the estimated value of time was shown, which partly reflected differences in the profile of the respondents interviewed, the review showed a gradual increase in the value of time over time. The trend value also tended to be higher than the 2003 and 2010 CityRail values which was attributed to the CityRail surveys sampling all fare paying rail passengers (apart from young school children), adjusting for concession entitlement and weighting the market segment estimates to reflect the profile of CityRail patronage.

Without undertaking surveys frequently, the method used to update the values becomes important. Since 2005, the NSW wage index has been used and the review of overseas practice supports this approach rather than the consumer price index or a GDP deflator. However, the study also found that the association was likely to be less than proportional with the average value of time rising at a slower rate than the wage index.

A composite index using the NSW wage and CPI indices was also evaluated. For Sydney, 63% of rail trips are made by employed passengers and 37% by non-employed passengers. Weighting the respective wage and CPI indices by these percentages resulted in a closer match than a single variable index and required an elasticity of 0.96 to produce an exact fit.

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