Imputing transport usage and expenditure onto the IPART Household Survey

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GLOSSARY AND ABBREVIATIONS

ABS	Australian Bureau of Statistics
BTS	Bureau of Transport Statistics
Bureau of Transport Statistics	Operates as an independent entity within Transport for NSW to monitor and forecast transport system usage and performance. Formerly known as the Transport Data Centre
CPI	Consumer Price Index
HES	Household Expenditure Survey
Household Expenditure Survey	Conducted periodically by the ABS to collect detailed information about the expenditure, income, assets, liabilities and household characteristics of households throughout Australia.
Household Travel Survey	An ongoing survey conducted by the BTS to collect information about the day-to-day travel of people living in Greater Metropolitan Sydney.
HTS	Household Travel Survey (conducted by the Bureau of Transport Statistics)
IPART	Independent Pricing and Regulatory Tribunal
PT	Public transport
School Student Transport Scheme	Provides subsidised travel for eligible NSW school students on rail, bus and ferry services.
SSTS	School Student Transport Scheme
TDC	Transport Data Centre
Transport Data Centre	Former name of the Bureau of Transport Statistics

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1 INTRODUCTION

IPART is the independent regulator that determines the maximum prices that can be charged for certain retail energy, water and transport services in New South Wales.

IPART conducts periodic surveys to collect data about household consumption of gas, water and electricity. The information is used to assess impacts of price increases in these areas. It would be helpful to have similar data about public transport usage. However, extending the IPART household survey to include detailed information on transport usage is considered too expensive and complex to be feasible.

The Bureau of Transport Statistics (BTS) (formerly the Transport Data Centre (TDC) at Transport for NSW conducts a rolling survey of household transport usage that collects the kind of data that could be useful to IPART.

IPART asked NATSEM to combine BTS data with IPART's household survey data to create a data set that would allow assessment of household impacts across the range of services IPART regulates.

As a first step, a feasibility study was undertaken examining three options to combine BTS data with IPART data.

Following the feasibility study, a modelling approach was used to impute the number of public transport trips by bus, train and ferry onto the individual household records of the IPART data. Average cost per trip by bus, train and ferry, and separately identified for combo tickets, were derived from the Household Travel Survey 2009/10. The average costs were applied to the data on no. of trips to derive total expenditure per household on a daily and weekly basis.

This report constitutes the final phase of NATSEM's work to impute public transport information on the IPART Electricity, Gas and Water 2010 household survey.

The report starts with a brief overview of the sample population from the two surveys in section 2. It describes the predictive variables in section 3 and the imputation of some household characteristics relevant to public transport usage in section 4. The methodology to estimate public transport (PT) usage and expenditure is described in sections 5 and 6 respectively and section 7 concludes.

2 OVERVIEW OF THE IPART AND TDC DATASETS

2.1 DESCRIPTION OF THE SAMPLE

Table 1a shows selected statistics on the TDC and IPART samples, and these are also compared to the 2006 census. There are some differences between the two survey samples, particularly with respect to dwelling type and ownership status. Note that the IPART sample was weighted while the TDC sample was not weighted. Possibly due to its larger sample size, the TDC sample is closer to census figures than the IPART sample. Also, the TDC and census data include Newcastle, while the IPART data does not. Further, the IPART survey had some exclusions: households that had occupied the dwelling for less than 15 months, those for whom the dwelling was not their primary place of residence or where the dwelling was a mobile home, were excluded from the survey (Independent Pricing and Regulatory Tribunal 2010).

Table 1a Selected sample characteristics

	2006 census %	TDC %	IPART 2010 %
Total no. of households	-	9607	2193
Region		100.0	100.0
1 Sydney SD		83.1	89.0
2 Newcastle[1]		8.9	0.0
3 Illawarra SD		8.0	11.0
Dwelling type	100.0	100.0	100.0
1 House	69.7	71.2	62.1
2 Semidet	9.8	11.5	12.2
3 Flat	19.0	16.6	25.7
4 Other	1.4	0.7	0.0
Ownership status	100.0	100.0	100.0
1 Owned	33.2	40.0	57.5
2 Paying off	30.2	31.0	23.2
3 Renting-public	4.4	5.2	5.0
4 Renting-private	23.2	22.6	13.2
5 Other & not stated	8.2	1.0	1.1
Household structure	100.0	100.0	100.0
1 Living alone	22.8	20.7	23.1
2 Couple only	24.4	25.2	24.1
3 Couple with children	31.4	34.5	35.8
4 Sole parent with children	10.9	8.1	11.4
5 Other	10.5	11.4	5.6
Average household size	2.7	3.09	2.79
Median HH weekly income [2]	1154	1271	1450

[1] Newcastle is included in the TDC survey but not in the IPART survey.

[2] Median household income was calculated from income in ranges (taking the midpoint of the selected range) and divided by 52 to convert annual to weekly income)

Sources: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics; Electricity, Gas and Water 2010 household survey, IPART NSW

2.2 PROPORTION OF THE SAMPLE USING PUBLIC TRANSPORT

The 2010 IPART household survey includes new questions on public transport information, including whether public transport was used *in the last week* and the type of public transport used. The IPART survey is conducted through telephone interviews, mainly of the person who pays the household bills.

The TDC data is based on the Household Travel Survey (HTS) which is a continuous survey. The survey consists of a face-to-face interview, with interviews carried out *every day* from 1st July to 30th June of each financial year (Transport Data Centre 2009). Selected participants provide detailed information of *all* trips undertaken in a 24 hour period. In addition to this detailed travel data, socio-demographic information is also collected on the household. This includes dwelling type, household structure and vehicle details, as well as age, gender, employment status, occupation and income of individual household members.

There are some differences between the IPART and TDC surveys, concerning who responds to the survey, as well as the actual questions asked on use of public transport. The IPART data is collected from one person in the household who is asked whether anyone in the household used public transport in the past week. The TDC trips data is collected from individuals in the household, who complete a travel diary to record the details of all travel undertaken for their nominated 24-hour period, and this is supplemented with socio-demographic information on the household.

Table 1b presents information on the proportion of households that reported using public transport by some household characteristics in the TDC and IPART data. The major difference is the period covered concerning usage of public transport: the IPART data reported that 60 per cent of households used public transport in the past week, compared to 25 per cent of households that used public transport within the last twenty four hours in the TDC data. The TDC unit record data was used to generate information on number of trips per day. Other data were then used to translate the number of trips per day into weekly terms.

There are some differences between the subset of households that used public transport, particularly with respect to ownership status and household structure.

Comparing the figures for the whole sample in Table 1a (last 2 columns), with the proportion for those using public transport in Table 1b (last 2 columns), it is evident that a larger proportion of the sample using public transport are those in Sydney and Illawarra, live in semidetached houses and flats, either paying-off their house or renting privately, and in household structures with children (couples or sole parents with children) or in the Other category.

Table 1b Characteristics of households that used public transport, NSW, 2010

	%Household using public transport to total households		Column percent	
	TDC (past 24 hours)	IPART (past week)	TDC (past 24 hours)	IPART (past week)
Number of households using public transport	2,346	1,307		
Proportion to total households	24.7	59.8		
	%	**%**	**%**	**%**
Region			100.0	100.0
1 Sydney SD	27.1	62.3	91.3	92.5
2 Newcastle	13.6	0.0	4.9	0.0
3 Illawarra SD	11.8	40.9	3.8	7.5
Dwelling type			100.0	100.0
1 House	21.6	56.3	62.2	58.4
2 Semidetached	28.2	67.1	13.0	13.7
3 Flat	35.6	64.7	24.1	27.8
4 Other	23.1	-	0.6	0.0
Ownership status			100.0	100.0
1 Owned	19.2	57.8	31.2	55.7
2 Paying off	26.5	62.1	33.3	24.1
3 Renting-public	25.0	55.5	5.3	4.7
4 Renting-private	32.1	65.3	29.4	14.4
5 Other & not stated	19.0	66.6	0.8	1.2
Household structure			100.0	100.0
1 Living alone	18.5	49.9	15.6	19.3
2 Couple only	16.3	53.2	16.7	21.5
3 Couple with children	29.2	64.8	40.8	38.8
4 Sole parent with children	28.9	71.0	9.4	13.5
5 Other	38.1	73.4	17.6	6.9

Sources: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics.
Electricity, Gas and Water 2010 household survey, IPART NSW

2.3 PUBLIC TRANSPORT VARIABLES

The key variables on public transport trips available on the TDC dataset (but not on the IPART dataset) are listed in Table 2. Aside from mode of travel, one needs to take into account fare type, ticket type and combo tickets when looking at public transport, particularly when setting average costs for trips.

Table 2 Key TDC variables on public transport trips

Variable	Response categories
Mode	1 Train 2 Bus 3 Ferry 4 Other modes (not public transport)*
Fare type	1 Full fare 2 Child fare 3 Free - Free school 4 Free - Child too young 5 Free – Other 6 Concessional - Pensioner, Aged 7 Concessional – Student 8 Concessional – Other 9 Group excursion and Other
Fare cost	Dollar value
Ticket type	1 Single ticket used 2 Return ticket used 3 Full day 4 Weekly 10Fortnightly 5 Quarterly 6 Yearly 7 Fixed multiple (e.g. Travel Ten) 8 Stored value card 9 Other
Combo ticket	1 Not a combo ticket – one type of travel only 2 Bus/rail 3 Bus/ ferry 4 Bus/rail/ferry 5 Other

* Vehicle driver, vehicle passenger, taxi, bicycle, walking.

Source: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics.

The usage of different modes of public transport are summarised in Table 3. The most prevalent modes of transport are bus only, train only, and bus and train only. Due to extremely small sample sizes for all other public transport modes, these were combined into a catch-all 'Other' category.

There are some differences in usage based on the TDC and IPART data and this is likely due to the difference in the length of the reference period – this being 'past 24 hours' for the TDC data and 'past week' for the IPART data. The longer the reference period, the more modes of travel and more trips one could potentially take. The proportion of households using one mode of travel (bus only and train only) are lower with a weekly rather than daily reference period, and the proportions for more than one mode of travel are correspondingly higher.

Table 3 Usage of public transport by mode of travel, 2010

	Sample size		Percentage	
	TDC	IPART	TDC (past 24 hrs.)	IPART (past week)
Total no. of households	2373	1307	100.0	100.0
Bus only	964	427	40.6	32.7
Train only	840	416	35.4	31.8
Bus and train only	483	368	20.4	28.2
All others	86	96	3.6	7.3
All others				
Ferry only	27	12	1.1	0.9
Bus, ferry and train	9	44	0.4	3.3
Bus and ferry only	32	24	1.3	1.8
Ferry and train only	18	16	0.8	1.2

Sources: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics.
Electricity, Gas and Water 2010 household survey, IPART NSW

3 PREDICTIVE VARIABLES TO MODEL PUBLIC TRANSPORT USAGE

3.1 BACKGROUND AND LITERATURE REVIEW

As part of any imputation the ability of variables to predict either public transport use or public transport expenditure by the household needs to be investigated. The quality of the imputation is highly reliant on the strength of the relationships between the common variables and the variables to be imputed.

Analysis done by TDC using the HTS found that socio-economic factors influenced the use of public transport. Significant factors that affected transport mode included age, labour force status, household type and income. The strongest relationships with lower public transport use were access to a vehicle, the number of vehicles in the household and having a driver's licence. Region within Sydney and accessibility to public transport were also factors in the frequency of public transport use (Corpuz 2007). Similar findings have been reported from the USA, where income and age, as well as region of residence, influence not only the choice of using public transport but the type of public transport used and the distance travelled. These authors suggest that some of the effect of income on the choice to use public transport relates to the likelihood of car ownership (Pucher and Renne 2003). It appears that, similar to the Australian study, access to a car is an underlying and significant predictor of public transport usage.

There are few studies that directly examine the relationship between socio-economic and demographic characteristics and public transport use, although there are a number of studies that look at differences in transport mode choices across demographic groups. Some of these studies are descriptive in nature. Others utilise multivariate discrete choice models where socio-economic and demographic characteristics enter as control variables; however, the statistics estimated of their

impact on transport mode choice are often not reported. For this reason this literature review focuses on a small number of descriptive studies where the demography of travel mode choice was the main focus of the research.

Pucher & Renne (2003) use the 2001 (US) National Travel Household Survey to investigate differences in vehicle ownership, travel mode, trip distance and travel purpose vary according to a range of demographic characteristics including household income, ethnicity, gender and age with income the primary focus. These authors find the total percentage of public transport trips to be quite low at just 1.6 percent of all trips. Four point six percent of trips taken by those with gross household incomes of less than $20,000 USD were made via public transport compared to between 0.9 and 1.4 percent of household with higher incomes. Pucher and Renne suggest that much of the effect of income on public transport usage is likely to be the result of greater levels of vehicle ownership among higher income households. Just under three quarters of households with an income of less than $20,000 USD have access to at least one car compared to 95 percent of households with incomes of between $20,000 and $39,000.

Corpuz (2007) uses the Sydney Household Travel Survey (HTS) to describe the relationship between transport mode choice and socio-demographic characteristics, trip purpose, time of day in addition to the convenience of access to different transport modes. While the HTS is a survey of household travel spanning Sydney, Newcastle and the Illawarra, Corpuz's analysis focuses on trips taken by residents within the Sydney Statistical Division. Corpuz finds access to a vehicle and holding a driver's licence are important determinants of public transport usage. On average only 8 percent of those with a licence made weekday trips on public transport compared to 31 percent of those without a licence. Similarly 35 percent of trips taken by those without access to a car were made by public transport compared to 5 and 12 percent of those in households with access to at least one car. Public transport usage was also found to vary with income and household structure but to a far lesser extent. Twelve percent of trips taken by those with household incomes under $35,000 were on public transport, only slightly higher than the 10 to 11 percent of trips taken by those with higher incomes. Lone persons and lone parents were also found to take slightly more public transport trips compared to couples.

While there is an extensive literature on variation in transport expenditure according to socio-demographic characteristics (Ferdous, Pinjari, Bhat & Pendyala, 2010; Thakuriah & Liao, 2003) there is a paucity of research that specifically focuses on public transport expenditure. One exception is the work of Swanepoel (2009) who uses the 2005 South African National Household Travel Survey to examine government policies associated with the subsidisation of public transport. Swanepoel finds that low income earners make the most intensive use of public transport in South Africa and that almost half of those on incomes of less than 6000 Rand a year pay more than 20 percent of their income in public transport costs.

3.2 VARIABLES ON THE IPART AND TDC DATASETS

The IPART data is sourced from IPART NSW's Electricity, Gas and Water 2010 household survey, while TDC data is based on pooled data over 2007 to 2009, from the Household Travel Survey 2009/10 from the NSW Bureau of Transport Statistics.

Socio-economic information is collected within both surveys. However, IPART collects information applicable to the household as a whole or to one responding individual. TDC collects its data for all household members, thus their data is available at the person level but can be aggregated up to the household level to be consistent with the IPART household level information. The common variables on both datasets are listed in Table 4.

Demographic information on the household

The common variables available include household income, dwelling type, ownership status, number of residents, number of motor vehicles and household structure. These variables, whilst trying to collect information about similar concepts, have variations due to the differences in both question wording and response categories. In the previous feasibility study (Lymer and McNamara, 2009) the common variables were compared in detail and reviewed with respect to how they may be aligned so as to allow for their use in imputation of public transport usage and expenditure onto the IPART database. Apart from the basic variables available on the two datasets, one additional variable that may be considered is 'needcar' a variable created from the combination of number of motor vehicles and numbers of adults in the household, that may indicate potential need for a car.

Usage of public transport

IPART added linking questions to its questionnaire to facilitate the imputation of public transport usage and expenditure. The 2010 questionnaire included questions about car ownership and whether anyone in the household had used public transport within the last week (SSTS and non-SSTS). This information is very timely and useful for our purpose.

Concession card status

Both IPART and TDC datasets have information on concession card status although there are intrinsic differences between the two. On the IPART dataset concession card applies to households with a Pensioner Concession Card or Veterans Affairs Gold health card, but does not include those with a Seniors Card.

On the TDC dataset there are three groups that get concessional fares: (a) pensioners and Seniors; (b) students; and (c) others. The last category includes the $2.50 Family Funday Sunday tickets and concessions to other groups including jobseekers.

Throughout this paper, we need to distinguish between concession card status and concessional fares. To make concession card status consistent between the IPART and TDC datasets, we defined concession cardholders to include households where the reference person/spouse is a pensioner or has a Senior's card. This corresponds to households that use concessional fares for pensioners/aged

on the TDC dataset. On the IPART dataset, pensioners are already identified. To this group we added Seniors (who we identified based on age and income eligibility), so pensioners and Seniors make up the concession cardholders group.

We did not count as concession cardholders those households who availed of concessional fare for (b) students or (c) others as described above.

Table 4 Common Variables

Variable	Response Categories
Household income per year	Less than 7,800 7,800-41,600 41,601or more
Dwelling Type	Separate House Semi-detached Flats Other
Ownership status	Owned fully/fully paid off Buying/paying off home Renting – private Renting – public/housing commission Other
Household structure	Person living alone Couple only Couple living with children Single parent living with children Other
Car ownership	Number of private vehicles owned
Number of residents	Integer, equal to or greater than 1
Number of adults (residents aged 15 years and over)	Integer, equal to or greater than 0
Concession card	No Householder/spouse is pensioner or has a Senior's card
SSD region	Inner Sydney Middle Sydney Outer Sydney (including Wollongong/Illawarra
Needcar (potentially needs a car)	No. of adults <= no of motor vehicles No. of adults > no of motor vehicles Household has no car
Whether used public transport	No Yes
Whether used SSTS (Free-School) public transport	No Yes

Location

There is some scope to consider variables on location, such as region at a gross level, or even disaggregation up to the statistical subdivision (SSD) particularly for Sydney. On both surveys, it is possible to distinguish those households living in Sydney including Gosford, Wyong and Blue Mountains, Illawarra and Newcastle. The Sydney statistical division is extremely large and likely to have considerable variation in terms of public transport usage and average cost. Taking this into account, we created an SSD based regional classification dividing Greater Sydney into five areas: Inner, Middle and Outer Sydney, Newcastle and Wollongong/Illawarra. (Newcastle was not included in the 2010 IPART survey.)

Considering the categories, dwelling type, ownership status, number of residents and number of residents aged less than 15 years offer similar categories. Consequently, these variables are readily usable across the two surveys. Household income has very different categories offered to respondents, in addition to IPART explicitly asking about the household and TDC asking about the individual and then combining the individual responses for each household. However, there are three categories common in both surveys.

4 MODELLING SELECTED CHARACTERISTICS OF HOUSEHOLDS

4.1 HOUSEHOLDS WITH FREE FARE

Free fare includes three fare types:

a. free travel on the School Student Transport Scheme (SSTS),
b. free travel for children that are too young, and
c. free travel – other

The SSTS is for qualified students up to 18 years of age. As households using SSTS are already identified on the IPART dataset, only Free-Too young to pay and Free fare–Other were allocated to households (taking into account household structure and age of the respondent, among other variables).

While the proportion of households qualifying for SSTS public transport is lower on IPART, we opted to leave this as is. Further, of the total number of households identified to be using SSTS travel, we excluded 9 records which did not have consistent information on household structure/ presence of children. While children on the TDC and IPART datasets are defined to include those up to 15 years old only, SSTS provides free transport for students/TAFE up to 18 years old so households with no children may have SSTS public transport trips

Households eligible for free travel for children too young were selected from households with these characteristics: in couple with children or single parent with children, until the proportion of households was close to the proportion on the TDC dataset. Households eligible for free travel –

other were selected at random, from all household types, until the proportion of households was close to the proportion on the TDC dataset.

The resulting number of households identified or imputed to have free fare is presented in Table 5. About 12 per cent of households have both free fare and non-free fare public transport trips.

Table 5 No. of households and trips, by free fare/not free fare, 2010

		TDC trips		No. of households		% households	
		No.	%	TDC	IPART	TDC	IPART
Free fare	School - free	1165	15.8	416	132	17.7	10.1
	Child too young	126	1.7	39	25	1.7	1.9
	Others - free	259	3.5	116	86	4.9	6.6
	Total	1550	21.0	551	212	23.5	16.2
Not free fare		5843	79.0	2076	1256	88.5	96.1
Overlap (free & not free)		0	0.0	281	161	12.0	12.3
TOTAL		7393	100.0	2346	1307	100.0	100.0

Free public transport trips constitute a fairly large proportion of all trips at 21 per cent of the total. At the household level when trips taken by all members of the household are summed up, 23.5 per cent of all TDC households take at least one trip on 'free fare'. The corresponding proportion on the IPART dataset is lower at 12.3 per cent, mostly due to the low proportion of households identified to have SSTS trips.

4.2 HOUSEHOLDS WITH SENIORS CARDS

To make the definition of concession card on the IPART and TDC datasets consistent we identified on the IPART dataset the households most likely have Seniors cards based on age of the respondent (65 years or over) and annual income (more than $50,000 for single persons or $80,000 for couples).[1] The imputed Seniors cardholders constituted 10 per cent of total cardholders and 3.5 per cent of the total sample (77 Seniors out of the total sample of 2 193 weighted households).

4.3 HOUSEHOLDS WITH STUDENT OR OTHER CONCESSIONS

As described in section 4.2 we need to distinguish between concession card status, and concessional fares. Table 6 shows the distribution of trips by concession card (pensioner/Seniors card) and the household's use of concessional fare. Most trips that made use of student or other concessional fares were made by households with no concession card (with the proportions at 4.3 per cent for other concessional fares, 14.9 for student fares and 0.6 per cent for both other and student

[1] To obtain a NSW Seniors Card, the person must be 60 years of age or older and work no more than 20 hours per week in paid employment (*https://www.seniorscard.nsw.gov.au/faq/faq.asp*). We used household income as a proxy for the number of hours in paid employment.

concessional fares). Correspondingly, the proportion of trips on student or other concessional fares for households with pensioner/Senior's cards was much lower (0.4 per cent for other concessional fares and 1.1 per cent for student fares).

Table 6 Distribution of trips by concession card status and fare type, 2010

Fare type	Concession card status		Total trips
	Pensioner/ Seniors card	No concession card	
	No.	*No.*	*No.*
Did not use student/other concession	961	4,855	5,816
Used 'other' concession only	31	321	352
Used student concession only	82	1,100	1,182
Both 'other' and student concession	-	43	43
Total	**1,074**	**6,321**	**7,393**
	%	%	%
Did not use student/other concession	13.0	65.7	78.7
Used 'other' concession only	0.4	4.3	4.8
Used student concession only	1.1	14.9	16.0
Both 'other' and student concession	0.0	0.6	0.6
Total	**14.5**	**85.5**	**100.0**

Source: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics.

The modelling approach we opted for is to identify households that would be eligible for student and other concessional fares.

Households that used student concession fares were selected at random from all households that used public transport with a few exceptions: we excluded one-person households (person living alone) and couple-only households where the respondent is 25 years or older. The households using student concession fares identified on the IPART dataset constituted 16.6 per cent of all households that used public transport.

'Other' concessional fare households were selected at random from all households and comprised 5.4 per cent of total households that used public transport.

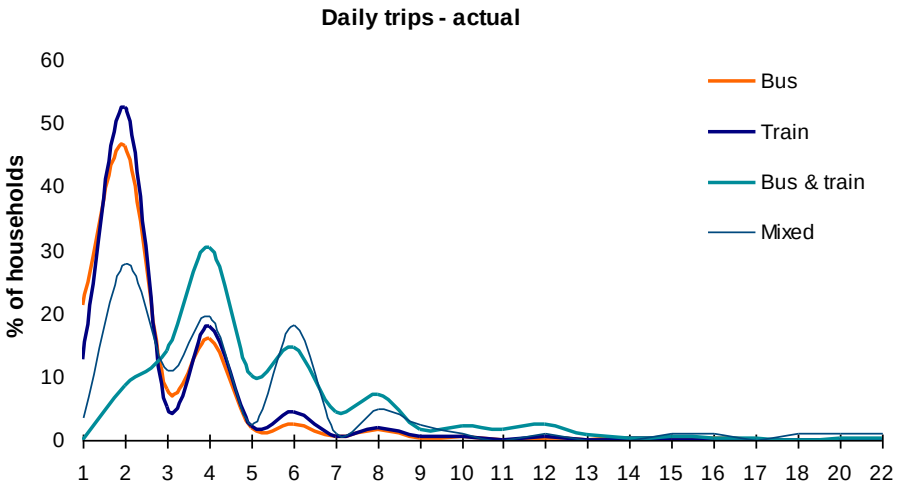
5 MODELLING NUMBER OF PUBLIC TRANSPORT TRIPS

5.1 DAILY TRIPS

The HTS data on trips is based on trips made by persons in sampled households within the last 24 hours, with the data being collected for all persons within the sampled households. While more information on trips is available at the 'trips' level and the person level, the data was aggregated to the household level, to be comparable with the IPART data. The distribution of daily trips (Figure

1a) shows that there are peaks in the no. of trips at *even* numbers, indicating that many trips are two-way (e.g. between home and work or home and school).

Figure 1a Actual no. of public transport trips, Greater Sydney, 2010



Source of data: NSW Household Travel Survey pooled data 2009/10

Initial imputation - modelling number of trips

The imputation of trips was done separately for SSTS and non-SSTS trips.

SSTS trips constitute just a small proportion (about 5 per cent) of total public transport trips. This was imputed simply based on the distribution of SSTS trips by mode of transport on the TDC dataset.

Non-SSTS trips constitute the bulk of total trips. This was imputed using a modelling approach. While a modelling approach is not expected to yield optimal results in terms of capturing the peaks in the data at even numbers of trips, it was viewed as a simple method to get a first approximation of the number of public transport trips per household taking various characteristics of households into consideration. Various modelling approaches appropriate for count data were trialled, including poisson, negative binomial and even normal regression. The model that showed the best fit was the poisson distribution. The regression results are summarised in the next table.

The results indicate that the model is correctly specified model with the Pearson chi-square statistic and the deviance Goodness of fit divided by their degrees of freedom being close to the value of 1 (top panel of Table 7).

The analysis of parameter estimates in the next panel of Table 7 show detailed results for various categories: household size (positive effect on no. of trips), number of motor vehicles (negative effect), 'needcar' (less trips if needcar = 0 or 1), region (Inner and Middle regions have more trips than the Outer region), travel mode (all modes have less trips relative to 'Mixed') and concession card status (non-cardholders or card1 = 0 have less trips). The coefficient on middle range incomes

(above $41,600) is negative but not statistically significant. All household types (particularly those who live alone), have less trips relative to the base household structure 'other'.

Nearly all the explanatory variables included in the model were all found to have a statistically significant contribution to the variation in number of trips, as indicated by low values for Pr > ChiSq in the bottom panel of Table 7 on LR statistics. The only exception is the 'middle income' variable with a probability > ChiSq of 0.5148. As indicated by Pucher and Renne (2003), some of the effect of income on the choice to use public transport relates to the likelihood of car ownership. As there are already two variables related to this (number of motor vehicles and potential need for a car) it is not surprising to find that income by itself does not significantly affect number of trips.

Table 7 Regression Results

Dependent variable: No. of daily public transport trips – excluding SSTS trips

7a. Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	2060	1505.11	0.7306
Scaled Deviance	2060	1505.11	0.7306
Pearson Chi-Square	2060	1739.01	0.8442
Scaled Pearson X2	2060	1739.01	0.8442
Log Likelihood		1001.52	

7b. Analysis of Parameter Estimates

Parameter		DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept		1	1.7906	0.0945	358.7	<.0001
Size of household		1	0.0566	0.0132	18.4	<.0001
Number of cars		1	-0.0863	0.021	16.9	<.0001
Needcar	0	1	-0.1351	0.0553	6.0	0.0147
Needcar	1	1	-0.0984	0.0445	4.9	0.0271
region_ssd3	Inner	1	0.0621	0.0395	2.5	0.1162
region_ssd3	Middle	1	0.0676	0.0396	2.9	0.0882
region_ssd3	Outer	1	0	0	.	.
PT type	1 Bus	1	-0.7193	0.059	148.6	<.0001
PT type	2 Train	1	-0.5943	0.0577	106.1	<.0001
PT type	3 Bus and train	1	-0.0196	0.0586	0.1	0.7383
PT type	4 Others	0	0	0	.	.
Concession card	0	1	-0.173	0.0387	19.9	<.0001
Concession card	1	0	0	0	.	.
Middle income	0	1	-0.0071	0.0351	0.0	0.8396
Middle income	1	0	0	0	.	.
household type	1 Live alone	1	-0.2943	0.0576	26.2	<.0001
household type	2 Couple	1	-0.0862	0.0468	3.4	0.0658
household type	3 Couple kids	1	-0.0878	0.0355	6.1	0.0133
household type	4 Sole parent	1	-0.1263	0.054	5.5	0.0193
household type	5 Other	0	0	0	.	.

7c. LR Statistics For Type 1 Analysis

Source	Deviance	DF	Chi-Square	Pr > ChiSq
Intercept	2279.9			
Size of household	2242.1	1	37.8	<.0001
Number of motor vehicles	2139.3	1	102.8	<.0001
Needcar	2131.9	2	7.4	0.0249
Region_ssd5	2122.3	2	9.6	0.0083
PT type	1552.6	3	569.7	<.0001
Concession card	1535.8	1	16.9	<.0001
Middle income	1535.3	1	0.4	0.5148
Household type	1505.1	4	30.2	<.0001

Source: NATSEM estimates based on NSW Household Travel Survey pooled data 2009/10

The regression model was then applied to the IPART data, to impute the no. of daily public transport trips by the four modes of travel. The resulting distribution of trips was uni-modal, peaking at 2 trips for 'bus only' and 'train only', and between 4 and 5 trips for bus/train, and mixed modes respectively.

Calibrating imputed number of trips

The imputed no. of total daily trips, referred to as 'initial imputation' was modified to more closely follow the distribution of actual trips in the benchmark or TDC data. This was done taking into account three variables: unimode, needcar and concession card status:

Unimode is a dummy variable with three groups, that distinguishes between travel on one mode only (bus only or train only with unimode = 1); travel using 'BT' (bus and train); and all other combinations with ferry ('BF', 'TF' or 'BTF). By definition, multimode travel would involve more trips than unimode. We opted to use 'unimode' rather than to differentiate between different travel modes such as 'bus only' and 'train only', or between other combinations, in order to maximize sample size.

Needcar combines information from two variables on no. of adults (persons aged 15 and over) and number of motor vehicles in the household. There are 3 values of needcar: 0 when the number of adults is less than or equal to the number of cars, indicating that the household has sufficient number of cars; 1 when the number of adults is greater than the number of cars, indicating potential need for public transport, and 2 when the household has no car, indicating a potentially high need for public transport.

Concessional fare There are distinct patterns in public transport usage based on concessional fare type. More than any other variable, concessional fare type shows up differences in the use of public transport with respect to ticket type. Ticket type information (whether single ticket, return, full day, weekly, quarterly, yearly etc) is not available in the IPART data and it cannot be used as a predictive variable, so concession card is a good proxy variable.

The procedure to calibrate imputed trips was as follows: For each of the groups cross-classified by the unimode, needcar and concession card variables, the household records were ranked from lowest to highest number of imputed trips. The TDC distribution by these variables (Table 8) was then used to revise the initial number of trips.

To give an illustrative example, let's take the first column of Table 8 to describe how bus trips were calibrated. Bus trips are classified as unimode. For this example we focus on households that used 'bus only' (unimode), needcar=0 (no potential need for a car as the number of cars in the household is more than or just equal to the number of adults) and 'General' with no concession on public transport trips. For this group there were too many households imputed to have 2 and 3 trips, and not enough households imputed to have just 1 trip or 4 trips. The calibration selected the first 2.0 per cent of households with these characteristics (unimode=1, needcar=0 and card=0), most of who had been imputed to have 2 trips, and assigned them only 1 trip. The next 25.7 per cent of households had been imputed to have 2 trips and no changes were made on them. The next 15.8 per cent of households had been assigned 2 trips and they were assigned 3 trips instead of 2. The next 33.7 per cent of households included those who had been assigned 2 or 3 trips, and were now assigned 4 trips, and so on. Note that the table has been top-coded at 12 or more trips. To modify this, households initially imputed to have 12 or more trips were reallocated to potentially have 12, 13, up to 22 trips based on the actual distribution of trips in this higher range.

Table 8 Benchmark distribution of no. of daily trips, NSW, 2010 (%)

	Needcar=0				Needcar=1				Needcar=2			
	General		Concessional		General		Concessional		General		Concessional	
	Uni-mode	Multi*	Uni-mode	Multi*	Uni-mode	Multi*	Uni-mode	Multi*	Uni-mode	Multi*	Uni-mode	Multi*
1	2.0	20.3	0.0	19.6	0.5	18.6	0.0	17.4	0.0	16.9	0.0	16.1
2	25.7	60.5	4.8	55.4	13.4	53.0	5.9	47.8	6.3	47.1	9.7	54.0
3	15.8	3.5	9.5	5.4	16.6	6.7	11.8	2.2	8.9	8.0	16.1	10.5
4	33.7	12.8	38.1	16.1	30.4	14.5	23.5	19.6	32.9	19.1	35.5	10.5
5	11.9	0.9	9.5	1.8	9.7	2.3	2.9	0.0	6.3	2.2	9.7	1.6
6	9.9	1.3	33.3	1.8	12.4	2.6	14.7	8.7	17.7	3.6	16.1	4.8
7	0.0	0.0	0.0	0.0	4.6	0.6	8.8	0.0	6.3	1.3	6.5	0.0
8	0.0	0.4	0.0	0.0	3.7	0.9	14.7	0.0	10.1	1.3	3.2	1.6
9	0.0	0.2	0.0	0.0	2.8	0.1	2.9	0.0	0.0	0.4	0.0	0.8
10	0.0	0.0	4.8	0.0	2.8	0.6	8.8	2.2	3.8	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	1.3	0.0	0.0	0.0
12+	1.0	0.0	0.0	0.0	2.8	0.1	5.9	2.2	6.3	0.0	3.2	0.0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

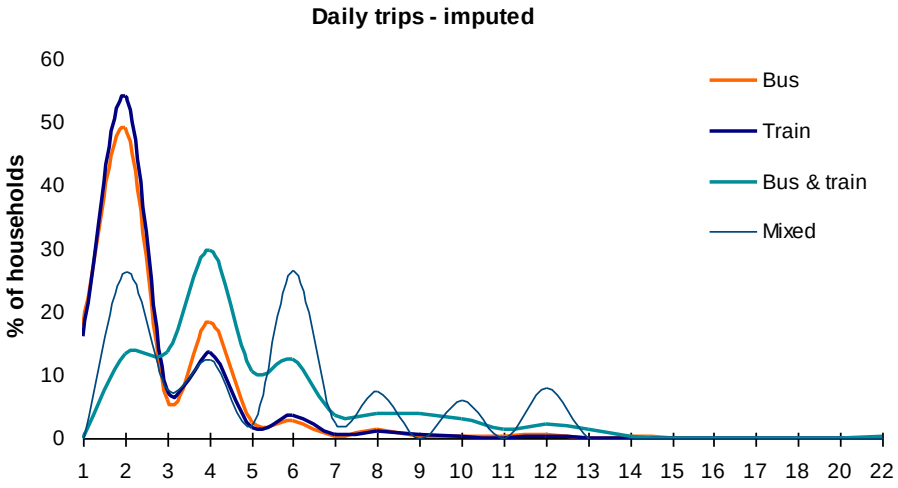
* Multimode was further disaggregated between 'BT' and 'other combinations' but that breakdown is not presented here.

Source: NATSEM calculations based on NSW Household Travel Survey pooled data 2009/10.

In conclusion, the distribution of no. of daily trips by the variables on concession card status, unimode and needcar was used as a benchmark by which to align the imputed distribution of trips. The resulting calibrated distribution of imputed trips is presented in Figure 1b. This second set of results more closely follows the actual distribution of trips as in Figure 1a.

The benchmarking only took into account the three variables on unimode, needcar and card status to ensure sufficient sample size within each group. Thereafter, we looked at the distribution of the final set of imputed trips when cross-classified by other variables including number of motor vehicles, household size, household structure and household income. With few exceptions, the imputed distribution of trips is reasonably close to the actual distribution based on TDC data.

Figure 1b Calibrated imputed no. of public transport trips, NSW, 2010



Source: NATSEM estimates.

5.2 ALLOCATING FREE FARE TRIPS

After imputing the total number of non-SSTS trips, the next step is to separate out free fare, non-SSTS trips so that this can be costed differently (i.e. cost = $0). These free fare trips include free fare-children too young and free fare-other.

Free fare trips for young children on the TDC dataset constitute slightly less than half of total non-SSTS trips (42.6 per cent – see Table 9a) of households that have this type of free fare. This makes sense as young children need to be accompanied. Hence about half (or slightly less) of the total trips of such households were allocated to be free fare. For example households with 2 daily trips were allocated 1 trip as free fare; households with 4 trips were allocated 2 trips as free fare; households with 5 trips were allocated 2 trips as free fare, and so forth.

Free fare trips–Other on the TDC dataset, constitute 77.1 per cent of total non-SSTS trips of households that have this type of free fare. Of all households with free fare trips – Other on the TDC dataset, these free fare trips constitute 77.1 per cent of total non-SSTS trips.

Table 9a Benchmark distribution of no. of daily trips, NSW, 2010 (%)

Proportion of non-SSTS trips of household that are free fare	Households with free fare – child too young %	Households with free fare – other %
Up to 25%	20.5	7.8
Up to 50%	64.1	25.0
Up to 80%	15.4	6.9
100%	0.0	58.6
Average	**42.6**	**77.1**
TDC sample size	39	86

Source: NATSEM calculations based on NSW Household Travel Survey pooled data 2009/10.

5.3 ALLOCATING TRIPS BY TRAVEL MODE AND COMBO STATUS

The imputed number of total non-SSTS trips at the household level was broken down by travel mode. The 'bus only' and 'train only' trips did not need any change. The 'bus and train' trips were allocated to be either bus or train trips based on proportion of either bus or and train trips in the TDC dataset on 'bus and train' trips and also taking into consideration the number of trips. The allocation of other mode combinations to single mode was done in a similar manner.

As an illustrative example Table 9b shows the distribution of 'bus and train' trips in the TDC dataset. The proportions in the table were used to allocate the same type of trips on the IPART dataset to be either bus trips or train trips.

For example, the first row indicates that for households with 2 'bus and train' trips, 100 per cent had 1 bus trip (and by deduction, 1 train trip). The second row indicates that for households with 3 'bus and train' trips, 65 per cent had 1 bus trip (and by deduction 2 train trips) and 35 per cent had 2 bus trips (and 1 train trip), and so forth.

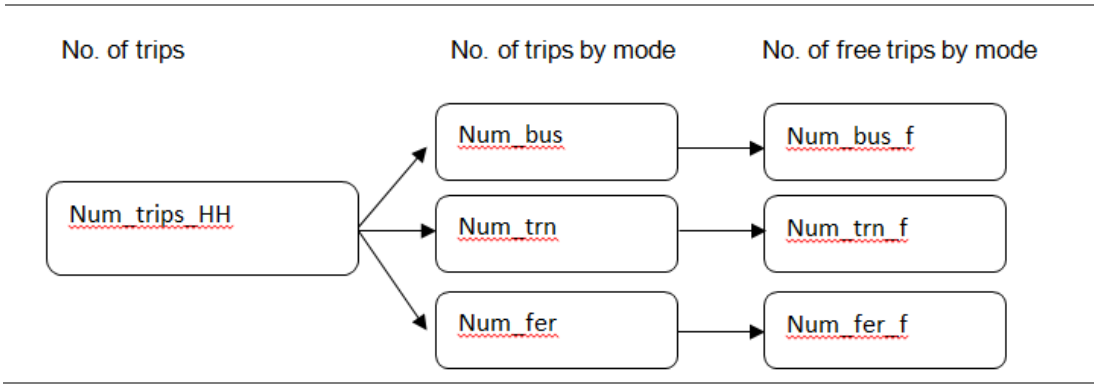
Table 9b Illustrative example: Distribution of 'bus and train trips' by total no. of trips and no. of bus trips

Total no. of bus & train trips	No. of trips by bus									Total trips
	1	2	3	4	5	6	7	8	10	
	%	%	%	%	%	%	%	%	%	
2	100	0	0	0	0	0	0	0	0	39
3	65	35	0	0	0	0	0	0	0	62
4	14	76	10	0	0	0	0	0	0	140
5	24	21	38	17	0	0	0	0	0	42
6	0	52	13	31	4	0	0	0	0	54
7	6	33	33	17	11	0	0	0	0	18
8	0	26	5	42	11	11	5	0	0	19
9	0	0	29	43	0	14	14	0	0	7
10	9	18	0	27	18	0	0	27	0	11
11	0	50	0	0	0	50	0	0	0	2
12	0	14	0	29	29	14	0	0	14	7
13	0	0	0	0	50	0	0	50	0	2
18	0	0	0	0	0	0	0	0	100	1
Total trips	110	181	46	43	11	5	2	4	2	404

Source: NATSEM calculations based on NSW Household Travel Survey pooled data 2009/10.

In addition to allocating total trips by mode, we identified the 'free' trips by mode as shown in Figure 2. SSTS trips were allocated by travel mode in the same manner as non-SSTS trips. SSTS trips were mainly by bus and train.

Figure 2 Allocating daily trips



The next step was to allocate non-SSTS trips to be 'regular' trips or 'combo' trips. Combo trips are trips where only one fare is charged for travel on more than one mode and could be for travel by bus/rail, bus/ferry or bus/rail/ferry. Combo tickets are usually more expensive than non-combo tickets but for those who need to use more than one mode of travel, this comes out less expensive on a per trip basis. Combo trips constitute about a fifth of total trips (see Table 10a). There is a special type of combo ticket – the $2.50 combo ticket - that is available for pensioners or on the Family Funday Sunday offer.

Table 10a Distribution of total trips by type

Type	N	%
Combo ticket	1419	19.2
Not combo (paid)	4424	59.8
Not combo & free (no fare charged)	1551	21.0
Total	7394	100.0

We classified public transport trips into three types: (1) not combo, (2) 'combo $2.50', and (3) 'combo other' (not $2.50). Looking at the distribution of TDC trips in Table 10b, there are two distinct groups that utilise combo tickets. The first group heavily utilises $2.50 combo tickets. The second group utilises the 'combo other' tickets to a smaller extent:

1. Cardholders (Concession cardholders) and those on 'Other' concessional fare; and
2. Non-cardholders (Full fare) and those on 'Student' concessional fare

Based on the distribution of trips by fare type and combo/non-combo status, the public transport trips by travel mode were allocated to be $2.50 combo or 'not combo' for cardholders and those with other concessions. For non-cardholders and students, their trips were allocated to be 'not combo' or 'combo other' (see Table 10b).

Table 10b Distribution of total trips by fare type and combo status

	No. of trips			%	
	Total	All Combo	$2.50 combo	Combo to Total	$2.50 to all Combo
Full fare	3740	**423**	7	11.3	1.7
Child fare	119	6	0	5	0
Free – School	1165	0	0	0	0
Free - Too Young	126	0	0	0	0
Free – Other	259	0	0	0	0
Concessional-Pension	897	**741**	730	**82.6**	**98.5**
Concessional-Student	798	**101**	4	12.7	4
Concession-Other	265	**132**	127	**49.8**	**96.2**
Group excursion	23	16	2	69.6	12.5
Other (specify)	2	1	0	50	0
Total	7394	1420	870	19.2	61.3

5.4 TRANSFORMING DAILY TRIPS TO WEEKLY

The imputed number of trips on a daily basis was transformed to a weekly basis. This transformation was based on information on number of days in a week that persons aged 15 years and over reported using public transport (Table 11).

Table 11 No. of days in a week that persons aged 15 years and over reported using public transport, NSW, 2010

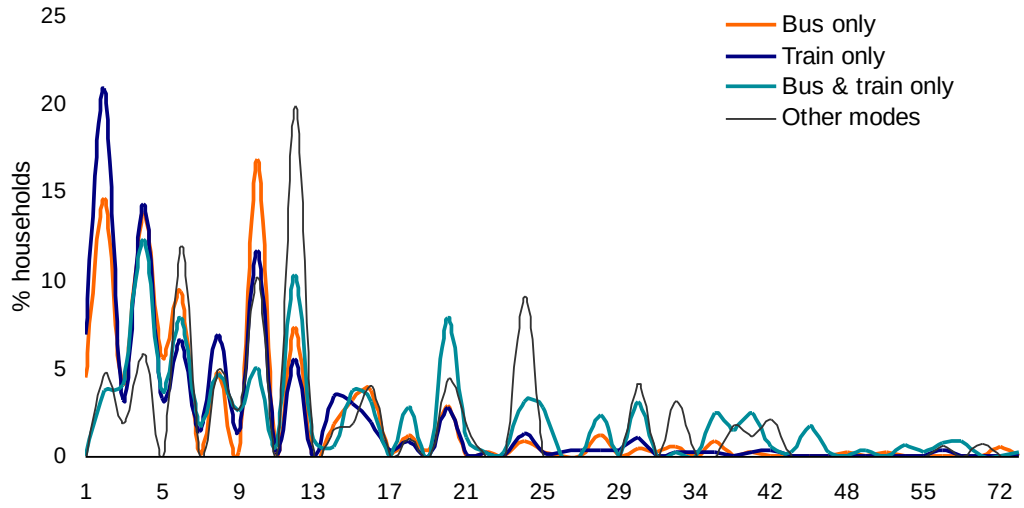
No. of days in the last week that this mode was used	Mode			
	Train only (%)	Bus only (%)	Bus and Train (%)	Others (%)
1	37	33	35	32
2	15	16	16	15
3	10	13	11	12
4	9	10	9	10
5	22	19	21	23
6	5	4	4	5
7	3	4	3	4
Total	100	100	100	100

Source: NATSEM estimates based on data from the Household Travel Survey pooled data 2009/10.

SSTS trips have a greater proportion travelling five times a week, as these trips are to and from school/study. The multiples and proportions provided by IPART are five days per week (85 per cent), 4 days per week (15 per cent) and 3 days per week (5 per cent). The no. of daily trips was multiplied by these factors to come up with weekly number of SSTS trips.

The SSTS and non-SSTS weekly trips were summed, and the resulting distribution of total number of weekly public transport trips is illustrated in Figure 3.

Figure 3 Weekly no. of imputed public transport trips, Greater Sydney, 2010



Source: NATSEM estimates.

The average number of daily and weekly trips per household (by region, concessional status and mode of travel), are presented in Table 12.

Table 12 Average number of trips per household[a] per week and per day, Greater Sydney region, 2010

Region	Total	General [b]				Concessional (pension cards) [b]			
		All general	Bus only	Train only	Others	All concessional	Bus only	Train only	Others
No. trips per week									
Greater Sydney	**11.0**	**11.3**	**9.0**	**8.4**	**17.0**	**10.3**	**6.8**	**7.1**	**16.0**
Inner Sydney	11.7	12.1	9.0	8.2	17.6	10.9	6.1	9.4	17.6
Middle Sydney	10.4	10.6	8.7	8.1	16.3	9.8	7.4	6.7	13.6
Outer Sydney	10.8	11.2	9.8	9.3	17.2	10.1	7.8	6.9	20.3
No. trips per day									
Greater Sydney	**3.6**	**3.4**	**2.7**	**2.6**	**5.1**	**3.8**	**2.7**	**2.8**	**5.5**
Inner Sydney	3.7	3.6	2.8	2.5	5.0	3.8	2.6	2.6	5.7
Middle Sydney	3.5	3.4	2.5	2.5	5.4	3.7	2.8	2.6	5.1
Outer Sydney	3.5	3.2	2.5	2.9	4.6	3.9	2.7	3.5	7.0

a/ Includes only households that use public transport, SSTS and non-SSTS trips.

b/ Concessional include households where the household reference person/ spouse has a pensioner or Senior's card. General includes all other households, including non-concession card households that make use of student or other concessional fares.

Source: NATSEM estimates.

6 MODELLING PUBLIC TRANSPORT EXPENDITURE

6.1 FACTORS AFFECTING PUBLIC TRANSPORT COST

Number of trips by ticket type

The unit cost of trips on single tickets is simply the cost of the single ticket. However for other types of tickets we usually need to divide the cost of the ticket by the assumed number of times the ticket will be used. Our assumptions on this were provided by TDC and IPART (Table 13). If the ticket type is other than single ticket, we divide the cost of the fare by the assumed no. of trips for that ticket type. In general the longer the duration of the ticket purchased, the lower the cost per trip.

Table 13 Assumption on no. of trips by ticket type

Ticket type	Bus	City Rail
Single	1	1
Return	2	2
Weekly	11	11
Fortnightly	22	24
Monthly	48	48
Quarterly	114	144
Annual	403	585
TravelTen	10	10

Source: IPART, TDC

Stored value cards

Aside from the ticket types listed in Table 13 there is another type called 'stored value cards'. In the TDC dataset stored value cards have a wide range of fare values. The factors by which to divide the fare cost were assumed to take the values in Table 14, differentiated by type of fare. For example if a stored value card on full fare was costed at $570 then we assume that the passenger was using an annual ticket, and we divide the $570 by 403 (403 taken from Table 13) to get a cost of $1.41 for each bus trip.

Table 14 Assumed cost range for stored value cards

	Full fare	Other (Child, Concessional, Other)
Return	Up to $24	Up to $11
Weekly	$25 - $59	$12 - $29
Monthly	$60 - $204	$30 - $102
Quarterly	$205 - $569	$103 - $299
Annual	$570+	$300+

Uprating fares to 2010

The TDC dataset consists of pooled trips data from 2007 up to 2009 with the fare cost not being adjusted to any particular year. The fare cost for each wave was converted to 2010 prices using urban transport CPI index values. The inflators were 1.12, 1.06 and 1.01 respectively for the 2007, 2008 and 2009 values.

Combo tickets

Combo tickets include tickets that can be used on more than one mode of travel with one fare charged for all trips included in that travel. Hence trips paid for using combo tickets are quite low cost as we divide the fare by the no. of trips to get the unit cost per trip. Combo tickets (a lot of which were priced at $2.50 in the dataset) can have a very low unit cost per trip. About 19% of all trips were paid for using combo tickets as shown in Table 10a.

Concessional fares

Concessional fare is a key variable that affects expenditure on public transport. Table 15 shows the distribution of households in the sample that used concessional tickets. 85 per cent of the trips of concessional/cardholder households are on concessional fare. The proportion is much lower for households with student concessions at 56 per cent, and households with other concessions at 63 per cent.

Table 15 Proportion of household trips on concessional fare

Proportion of trips on concessional fare, to total trips of household (HH)	Concessional	General		All HHs using concess'l fare
		Student	Other	
	%	%	%	%
< 25%	3.2	5.4	8.2	3.3
25-50%	7.4	25.2	18.4	14.2
50-75%	4.2	12.1	9.2	9.0
75-95%	0.3	1.0	1.0	0.7
100%	84.9	56.2	63.3	72.8
HHs w/concessional fare	312	313	98	703
Total HHs				2348
% Total HHs	13%	13%	4%	30%

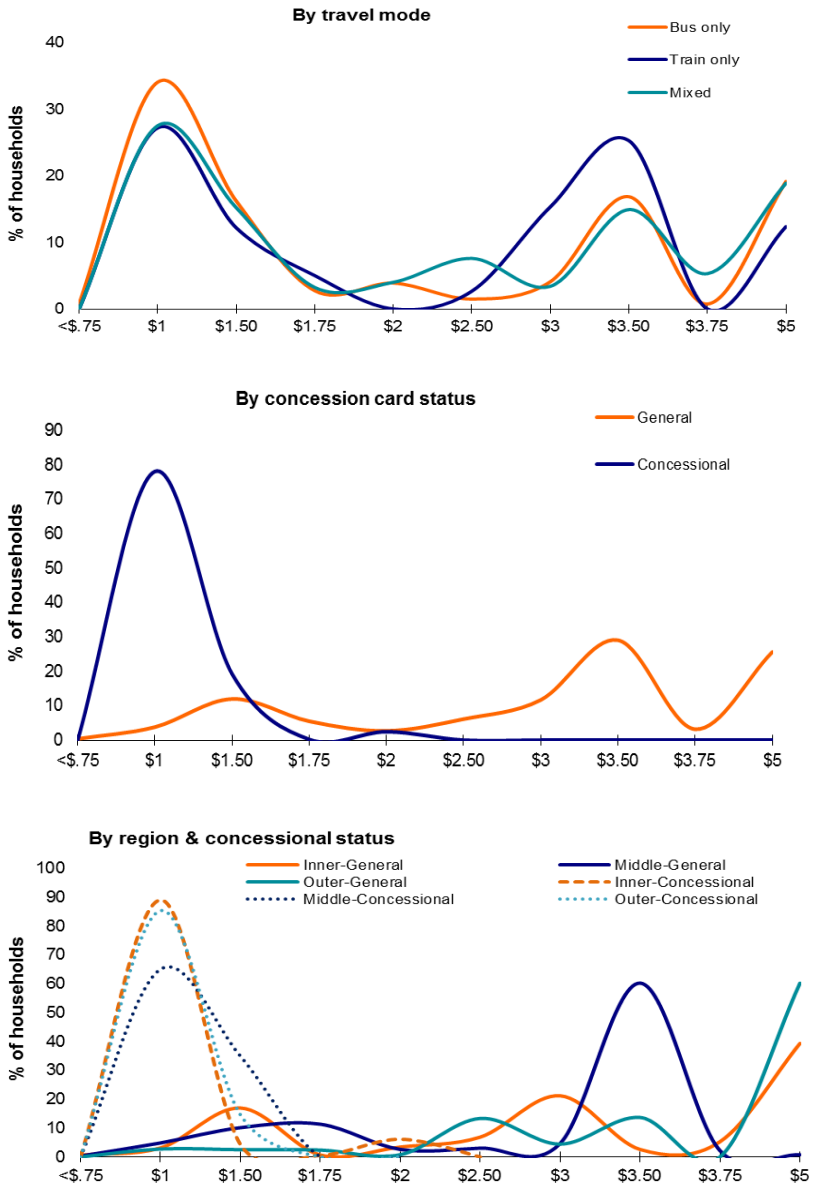
Source: Household Travel Survey pooled data 2009/10, NSW Bureau of Transport Statistics.

6.2 MODELLING FARE COST PER TRIP

The distribution of average fare cost per household per trip based on TDC data is shown in Figure 4. By travel mode, 'bus only' has the greatest proportion of households paying up to $1 per trip although the proportion of households with 'train only' and other mixed modes also peaks at $1. The other price range with the greatest proportion of households is up to $3.50. As may be seen in the next chart by concession card status, the proportion peaks at 'up to $1' are for concession cardholders and for non-cardholders it is 'up to $3.50'.

By region, the fare cost for Inner, Middle and Outer Sydney for non-concessional households looks similar, with about 66 per cent of trips ranging from around $3 up to $5.60 per trip. This excludes combo tickets whose average cost per trip is much lower at $1.30.

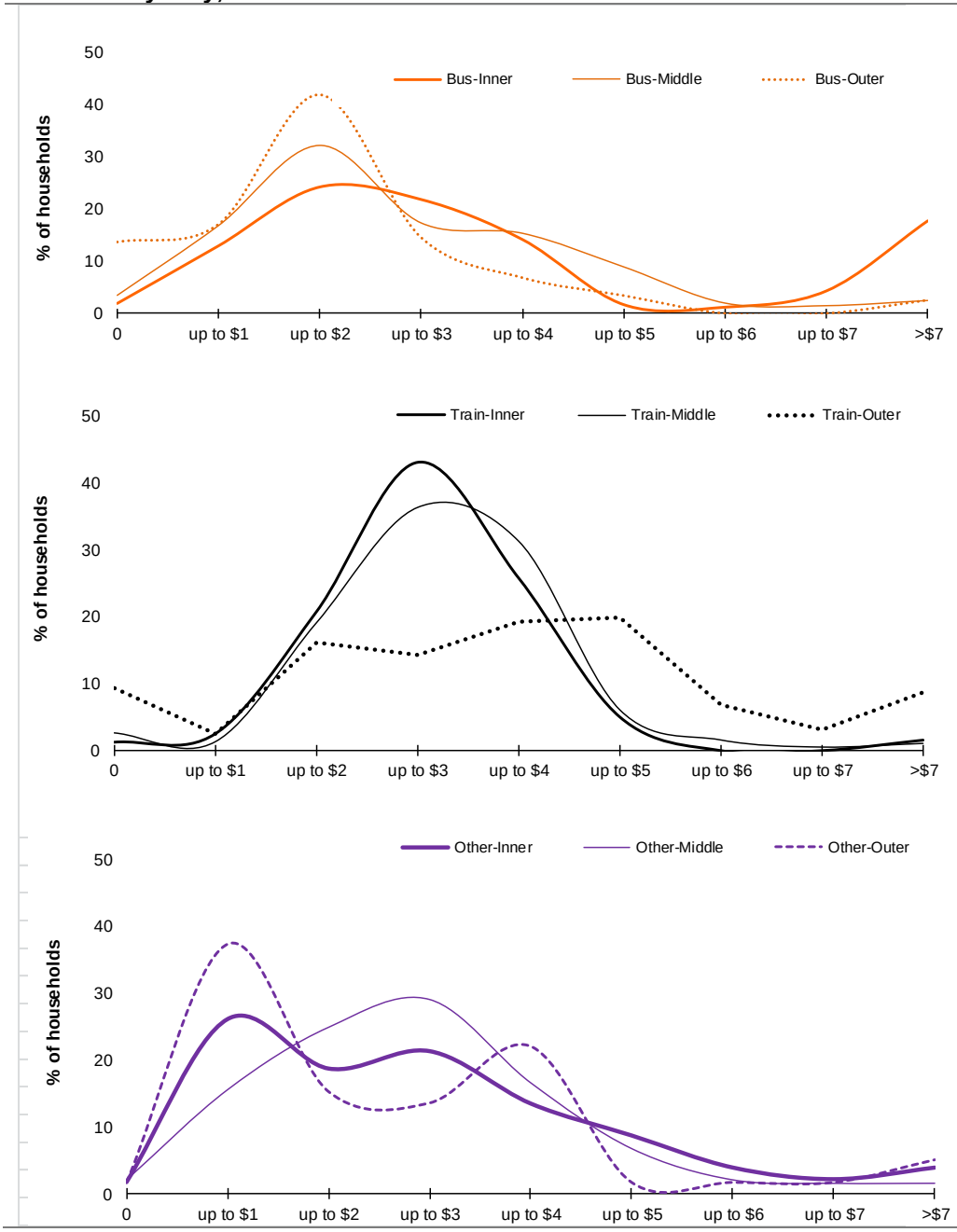
Figure 4 Distribution of average fare per trip per household, Greater Sydney, 2010



Source: NATSEM estimates using NSW Household Travel Survey pooled data 2009/10

Figure 5 shows the distribution of average fare cost by travel mode and region. It is noticeable that the average cost of bus trips is higher in Inner Sydney for both general and concessional travellers. While we would have expected most trips in Inner Sydney to be shorter and therefore cost less, this is not the case. This could be due to a combination of factors, including the higher proportion of Inner-Sydney bus passengers using single tickets, as well as the higher proportions paying full-fare, relative to other Greater Sydney regions /travel modes.

Figure 5 Distribution of average fare per trip per household, by region and mode, Greater Sydney, 2010



Source: NATSEM estimates using NSW Household Travel Survey pooled data 2009/10

The average fare cost assumptions are provided in Table 16, cross tabulated by travel mode, concessional status and region. Note that these are average costs per trip.

Table 16 Average fare cost assumptions per household per trip, Greater Sydney, 2010

Region	Average fare / cost per trip per household					No. of public transport trips (excluding free fare)					Total
	Bus	Train	Ferry	Combo other	Combo $2.50	Bus	Train	Ferry	Combo other	Combo $2.50	
	$	*$*	*$*	*$*	*$*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
General											
Inner Sydney	5.0	3.0	5.0	1.3		766	886	49	330		2,031
Middle Sydney	3.5	3.2	4.2	1.3		372	959	28	98		1,457
Outer Sydney	3.5	5.0	5.6*	1.3*		87	286	5	8		386
Student concessional											
Inner Sydney	2.5		2.5	0.6		162		114	60		336
Middle Sydney	1.8	1.6*	2.1	0.7		160	10	180	26		376
Outer Sydney	1.8		2.8	0.8		30		41	11		82
Concession card holders/ Other concessional											
Inner Sydney	1.8		1.5		0.8	60		27		354	457
Middle Sydney	1.4	1.3*	2.1		0.9	85	2	41		268	396
Outer Sydney	1.3	1.3*	2.3		0.9	48	5	21		235	309
All	**3.7**	**3.3**	**2.7**	**1.1**	**0.9**	**1770**	**2148**	**506**	**549**	**857**	**5830**
						30%	37%	9%	9%	15%	100%

* Based on no. trips <=10

Notes: The average cost was applied to all households excluding those that pay zero fare.

Source: NATSEM estimates based on data from the Household Travel Survey pooled data 2009/10.

To simplify the modelling, student concessional average costs were allocated only to households that were not concession cardholders. Hence, 'general' (non-concessional) households were allocated either the general average costs on Table 16, or the student concessional average costs.

Concession cardholder households or those that made use of other concessional fare, were allocated the same average cost, shown at the bottom panel of Table 16.

6.3 TOTAL WEEKLY HOUSEHOLD EXPENDITURE ON PUBLIC TRANSPORT TRIPS

We calculated weekly household expenditure on public transport as the product of the unit fare cost per trip at the household level, multiplied by the no. of weekly trips imputed per household.

Weekly HH expenditure = Fare cost per trip x No. of weekly trips per household

The resulting average expenditure figures are summarised in Table 17, with the overall amount for households using public transport estimated at $23.00 per week, and a lower overall average of $12.50 if we include all households in the Greater Sydney region even those who do not use public transport. Dividing the $12.50 by $1450 (the median household income for all households surveyed), this indicates that overall, public transport expenditure constitutes about 0.9 per cent of household income in the Greater Sydney region.

Looking at the variation in average spending on public transport, the average expenditure on public transport is highest for those in outlying areas at $25.80 compared to other areas with those in Inner Sydney coming a close second at $25.50. When we include all households, the average weekly cost for those in Inner Sydney is the highest at $18.10, indicating that a greater proportion of people in Inner Sydney use public transport.

By mode of travel, the average expenditure on the catch-all category 'Other' is higher at $46.20 for the general population, and $14.00 for concession cardholders. This is because 'Other' includes all multimode travel that involves more trips, and hence higher expenditure

Table 17 Weekly household expenditure on public transport, Greater Sydney, 2010 ($)

	Weekly public transport expenditure per HH	General [a]				Concessional (pension cards) [a]			
		All modes	Bus only	Train only	Others	All modes	Bus only	Train only	Others
HHs using public transport									
Greater Sydney	**23.0**	**30.1**	**24.9**	**20.3**	**46.2**	**8.8**	**5.3**	**5.8**	**14.0**
Inner	25.5	33.9	27.7	16.6	50.6	8.0	5.0	5.5	12.4
Middle	19.5	24.5	21.3	16.2	40.2	9.5	5.9	5.8	14.5
Outer	25.8	35.0	22.8	35.0	45.5	8.7	5.6	6.0	18.3
All households									
Greater Sydney	**12.5**	**16.9**	**3.8**	**4.9**	**8.4**	**4.3**	**0.9**	**0.8**	**2.5**
Inner	18.1	23.8	7.0	3.0	14.5	5.5	1.8	0.4	3.5
Middle	10.2	13.3	2.7	4.4	6.4	4.4	0.8	1.0	2.9
Outer	10.3	15.1	1.8	8.8	4.3	3.1	0.6	0.9	1.3

a/ Concessional includes households where the household reference person/ spouse has a pensioner or Senior's card. General includes all other households, including non-concession card households that make use of student or other concessional fares.

Source: NATSEM estimates.

Concessional travellers noticeably spend less with the overall average weekly household expenditure at $8.80 (compared to $30.10 for the general population) as their tickets are priced lower.

How do these imputed amounts compare with actual expenditure? To verify this we looked at two sources of comparable data – the Household Expenditure Survey (HES) 2009-10, and the CPI or consumer price index. From the HES the average weekly expenditure for Sydney is $9.65 (relative to the imputed amount of $12.50) for all households and $23.16 (relative to the imputed amount of $23.00) for households that use public transport. These are weighted weekly expenditure values. This equates to 1 per cent of total expenditure for Sydney households.

The CPI estimate on average weekly expenditure on urban transport fares (for 8 capital cities as of June quarter 2011) is $10.14, so it is close to the HES figure. This amount constitutes 0.74 per cent of total expenditure in the 8 capital cities (ABS, 2011). However this CPI estimate includes expenditure on taxis, and is not specific to Sydney. Comparing Sydney relative to the other capital cities public transport cost is likely to be higher in Sydney.

These proportions of spending on urban transport based on the HES and CPI are broadly similar to the 0.9 per cent of PT cost to median household income that we estimated.

7 CONCLUDING NOTES

In summary, we used detailed data on trips from the Household Travel Survey 2009-10 and aggregated up the information to the household level. We used this TDC data on the distribution of number of trips and average cost per trip per household, to impute the same data onto the IPART 2010 survey data, and to estimate the total amount spent per household on public transport trips.

Our estimate of the proportion of Greater Sydney spending on public transport to median household income at 0.9 per cent is broadly similar to the proportions of spending to total expenditure of 1.0 per cent for Sydney based on the HES, and 0.74 per cent based on the CPI by expenditure group for 8 capital cities.

One caveat is that the estimates on number of trips and cost are based on TDC pooled data based on public transport usage and cost from 2007 to 2009. My Zone came into effect in April 2010 and overhauled and simplified the fare structure so public transport fares in NSW may have changed and would not reflect the existing system in 2011. Nevertheless it provides a baseline on the amount of spending on public transport up to 2009, and this estimate can be modified based on additional information on the direction and magnitude of change in public transport fares since then.

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