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Group travel and public transport use: the effect of fare discounts

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Abstract

Travellers preferences for travelling by car will continue to be a barrier to increasing public transport ridership, especially when there is more than one person travelling together (group travel). One way to make public transport more attractive is to provide fare discounts for group travel. This paper analyses the impact of group travel discounts on public transport demand using the three years pooled Sydney Household Travel Survey data. The use of public transport modes for joint household travel before and after the implementation of the Family Funday Sunday ticket scheme is analysed to test if group travel fare discounts bring about changes in travel behaviour (measured by the proportion of PT travel to total travel generation, travel patterns, kilometres of travel, degree of multimodal travel and the mode choice for joint travel). The results show no significant changes to travel behaviour, controlling for the impacts of potentially confounding factors. These findings suggest that the strict conditions for the travel party composition required by the Family Funday Sunday ticket limits its target population to a minor segment. Offering a discounted group travel ticket to all groups could provide public transport with the needed economic comparative advantage to compete with the car for group travel and may be required for changes to travel behaviour at an aggregate level to be observed. The paper suggests further investigations to provide evidence supporting the extension of public transport fare discounts to group travel on weekdays during off-peak hours.

Keywords Public transport; fare discounts; group travel; transport policy; Family Funday Sunday Ticket.

1. Introduction

Amongst Australian capital cities, Sydney has the most complex public transport (PT) network with little planned integration of services. This is reflected in the fares and ticketing policy with the only multi-modal product available until April 2010 being the Day Pass or DayTripper tickets but these were expensive relative to single trip tickets and did not cover travel on the extensive private bus operator network or light rail system (the cost of full day travel for non-concession holders being over A$16 in 2007 and increasing every year to A$22 in 2013 (IPART, 2008; NSW, 2013a). MyZone, a new fare structure, was introduced in April 2010 and this offered more opportunity for multi-modal fares for periodic tickets. Different levels of discount are offered to PT users based on the period covered by the tickets (weekly, multi purchase discount for bus (10 tickets for the price of 9), monthly, quarterly, yearly tickets), the time of day travelled (off-peak fares for rail users), and the category of travellers such as students, pensioners, disabled people, jobseekers, and children. The most generous element of a special category provision and with which this paper is concerned, is the Family Funday Sunday (FFS) which allows families to travel unlimitedly on trains, buses (private and government) and ferries on Sundays with a flat fare of $2.50 per person. The services were extended in Jun 2011 to include light rail travel opportunities. To be strictly eligible for this discount, the travelling group must be related by family and involve at least one child and one adult (NSW, 2011) although the strict condition of familial relationship is difficult to police.

The provision of FFS tickets has implications for revenue and capacity. Public transport services in Sydney are provided by both government (almost at arm's length) and private operators. All private bus operators, contracted to the New South Wales (NSW) government, are paid a per-km rate with fare revenue being retained by the government. There are different contractual relationships in place for the other providers participating in the provision of the FFS discount (both before and after MyZone introduction in April 2010) but in no case does the operator take the fare revenue risk. Thus, the loss of revenue (if any) due to the provision of FFS discounts is incurred by the government with no compensation scheme for operators being established. However, there are also potential capacity implications and the FFS could require the Government to provide financial compensation if extra capacity is needed to cater for additional travel demand, although in practice the revenue implication is much more important (Baker and White, 2010).

The underlying rationale behind the FFS fare policy is not explicitly documented. No detailed evaluation of this policy has been done although its implementation may have certain implications for increased PT patronage, social inclusion, modal shift, and health benefits. This paper is concerned with the impact of FFS tickets on PT patronage and travel mode of residents of Sydney. The evaluation of the impact of FFS scheme helps to inform policy development in the future such as discounted fares for group travel during off-peak hours on weekdays or the Sunday travel cap policy being implemented in the Opal card trials (NSW, 2013b). This paper provides an analytical approach to quantify the effect of the FFS discount on PT demand, using the Sydney Household Travel Survey (HTS) data and a typology of tours which distinguishes individual travel from joint household travel.

The remainder of this paper is organised as follows. The next section provides a discussion of various approaches which could be used to evaluate transport policy, transport programs and infrastructure projects. This highlights the role of key performance indicators (KPIs) in evaluation and selects appropriate KPIs for evaluating the effect of the FFS fare discount. This is followed by a description of the data sources and the identification of travelling groups eligible for discounted FFS fares. Descriptive and modelling results are then presented and the paper ends with a discussion of the implications for policy development and directions for further research.

2. Project and policy evaluations

With respect to project evaluation, an important distinction exists between *ex ante* and *ex post* evaluations. The evaluation of discounted FFS tickets conducted in this paper is an *ex post* evaluation. Four main approaches in *ex post* evaluations are cost-benefit (re)analysis, business value evaluation (e.g. investigating the revenue effect on PT operators), holistic evaluation (i.e. investigating the extent to which overall objectives have been met using various approaches and indicators), and performance measurement evaluation (Olsson et al., 2010). This paper uses the last approach which is discussed next.

The performance measurement approach is based on identifying KPIs to measure the effectiveness of an intervention. This approach therefore identifies factors that led to the decision to implement an intervention and evaluation of the effectiveness of the intervention is relative to these factors. For example, a voluntary travel behaviour change (VTBC) program, also known as individualised marketing, aims to find the means for individuals and households to change their travel behaviour (Jones and Sloman, 2003; Taylor and Ampt, 2003). The ultimate objectives of VTBC interventions are to reduce vehicle kilometre travelled (VKT), achieve mode changes to more sustainable travel modes without restraining individual mobility (Brog and John, 2001). Thus, the KPIs used to evaluate VTBC interventions are VKT, modal shift, the numbers of trips and activities made by the individuals or households. In an accident preventive study with a specific improvement to intersections, such as the installation of turning lanes or traffic signal controls, the KPIs might be the number of accidents. However, not all transport policies and infrastructure investments have their key objectives articulated before implementation and in many cases, a simple political decision appears to be the determining factor. In these cases the analyst needs to infer motivations and select appropriate KPIs for evaluating the effectiveness of change (Baker and White, 2010). The introduction of the FFS concessionary fare policy falls into this category. It is inferred in this paper that this fare policy aims to promote PT use on Sundays by providing multimodal discounted tickets to group travel. Appropriate KPIs will include the average proportion of PT journeys made on Sundays, the modes used in joint or group travel, PT travel distances undertaken by group travellers, and the number of multi-modal journeys.

There are two main research designs for measuring changes to the KPIs (collectively referred to as travel behaviour in this paper) in a population due to an intervention. One is based on repeated cross-sectional surveys and the other employs a longitudinal study on the same sample before and after the intervention. Stopher et al. (2009) and Richardson et al. (2004) discussed the advantages and disadvantages of these two methods and concluded panel data are the superior option for identifying changes in travel behaviour. However, data quality and availability are key issues in selecting an evaluation method (Flyvbjerg et al., 2005). In the absence of the longitudinal panel data, this paper uses repeated cross-sectional sample surveys from secondary data sources. This is not without methodological issues, which are discussed in the next section.

Repeated cross-sectional surveys need to assume that households in the ‘before period’ sample are equally representative of the population as those in the ‘after period’ sample (Stopher et al., 2009). This can be tested by comparing socio-demographics of the samples at the aggregate level, although the between-sample variation may not be significantly reduced. Second, a large sample size is required to detected changes in travel behaviour from repeated cross-sectional surveys (Richardson et al., 2004). Pooling multiple waves of surveys to form the ‘before’ and ‘after’ periods may provide enough observations for detecting changes. However, this may give rise to the issue of confounding factors in observational before and after studies. That is, during the evaluation period, changes in factors other than the intervention such as PT supply, PT fares, fuel prices, household income and car ownership could be the cause of changes in travel behaviour. To properly measure the net effect of the intervention, the effect of these confounding factors must be isolated and removed. This usually requires having a control group of households who face identical transport options and confounding factors but are not influenced by the intervention (Stopher et al., 2009). Using a control group, changes to travel behaviour due to time trends can also be measured (Elvik, 2002; Harwood et al., 2003).

Finding an appropriate control group is difficult in practice as the control group should be similar in all ways to the treated group, that is without socio-demographic and attitudinal differences (Stopher et al., 2009). As only eligible travelling groups are entitled to FFS discounts, the control group can only be households who are not eligible for the FFS program. Given the conditions of the FFS discount described above, the treatment group is households with children and the control group is households with no children. This is not an ideal way of creating a control and treatment groups since they are clearly differentiated by the presence of children which is likely to impact on family travel behaviour.

An alternative might be to use an Empirical Bayes (EB) method to determine the impact of each confounding factor to estimate travel behaviour for a treatment group. The EB evaluation approach is the state-of-the-practice in road safety studies where safety performance functions are used to estimate the accident rate as if the treatment (e.g., adding a signal control or turning lane) not been taken place (Elvik, 2002; Hauer et al., 2002; Harwood et al., 2003). This approach is taken in the modelling approach of this paper in evaluating the FFS policy, by developing a mode choice model to estimate the impact of the fare discount on PT use for group travel, controlling for potentially confounding factors. The next section describes the method in more details.

3. Methodology

3.1 Data sources

The main data sources used for the evaluation of the FFS policy include the Sydney Household Travel Survey (HTS), the level of service data, and land use data. A detailed description of these data sources can be found in Ho and Mulley (2013c) and Ho (2013). This section describes the most relevant characteristics of the datasets and the definitions of terms used in this paper.

The Sydney HTS, conducted by the Bureau of Transport Statistics (BTS), has been running continuously since 1997/98 using a face-to-face interview methodology. The surveys are carried out every day between July to June of each financial year with approximately 3,500 randomly selected households across the Sydney Greater Metropolitan Area (GMA) being surveyed about their travel patterns each year (BTS, 2011a). The data used in this analysis are pooled from the three waves of HTS data (2007/08, 2008/09 and 2009/10) which cover the launch of FFS tickets on Sunday 21 December 2008 but not any extensions post MyZone introduction. Choosing only fully responding households for analysis reduces the sample size of this dataset from 88,754 to 81,850 unlinked person trips.

An extensive cleaning and restructuring process was taken to transform the unlinked person trip dataset into a home-based tour dataset where a home-based tour is defined as a sequence of trips starting and ending at the home. This process created about 23,000 tours with nearly 6,500 tours being made on weekends. Given that FFS tickets are available on Sundays only and that modal shift from car to PT is an expected outcome of the FFS introduction, a tour dataset for journeys which were made on Sundays by car and/or PT was created and contained 2,532 eligible tours. For tours involving both PT and car modes, PT is used as the tour main mode with car being considered as a feeder mode. In this dataset, each tour is assigned a main purpose based on a pre-determined hierarchy with work being highest, followed by education, maintenance (shopping, personal business, drop-off/pick-up, accompany) and discretionary (social and recreation).

The level of service (LOS) data are obtained from the Sydney Strategic Travel Model (STM) (BTS, 2011b). Outputs of the Sydney STM are available in 5-year intervals from 2006 to 2036 and this paper uses data for the year 2006 as the Sydney HTS data are based on the 2006 zoning system. The LOS data are adjusted to take account of changes to ticketing system, PT fares, and fuel costs from 2006. Land use data are extracted from GIS layers provided by BTS and 2006 Census data conducted by the Australian Bureau of Statistics (ABS). Both land use and level of service data are matched with the tour-based dataset based on trip departure and arrival time with trip origin and destination coded into travel zones.

3.2 Identification of eligible travelling groups

To evaluate the effect of FFS policy on changes to travel behaviour, eligible travelling groups must be identified which by definition must include at least one adult and one child (under 16 years or school student up to 18 years) and be related by family (NSW, 2011). This can be done by looking at the travel party composition and ages of the travellers after the identification of joint household trips and tours from the Sydney HTS data. Ho and Mulley (2013a; c) describe in details the process of identifying joint household travel. For the purpose of this paper, tours are re-classified into two joint types with one tour type involving fully joint travel which is eligible for FFS discounts. The other group includes individual and partially joint tours, not eligible for FFS tickets, with the individual travel data being required for quantifying the impact of FFS discounts on total PT demand.

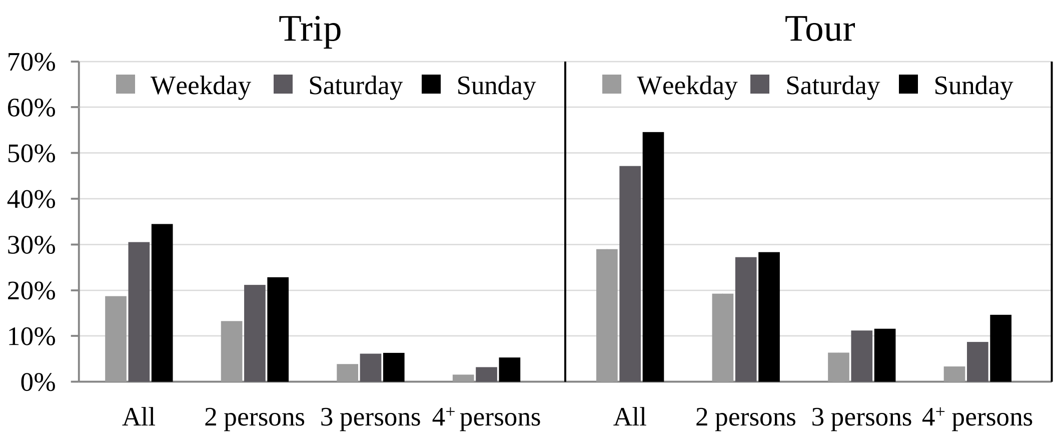
3.3 Analytical approach

This paper evaluates the FFS policy using descriptive and modelling analyses. The dataset is divided into two periods: 'before' and 'after' the implementation of the FFS policy. Statistical tests are conducted to compare travel behaviour of eligible households before and after using both trip-based and tour-based datasets. While some KPIs such as travel mode and travel generation can be investigated using either trip-based or tour-based analysis, other KPIs such as the degree of multi-modal travel and distances travelled are more relevant if based on tour-based information. However, a tour involves multiple trips and the tour-based dataset thus has fewer observations which may not provide enough observations for statistical tests. In these cases, analysis is performed on the trip-based dataset or multivariate analysis.

4. Aggregate analysis

Figure 1 shows the proportion of joint household travel to the total travel demand in Sydney on an average weekday, Saturday and Sunday. Joint travel accounts for a substantial proportion of the total trips and tours generated in Sydney, with a higher percentage on weekends than on weekdays. The majority of group travel involves two household members but the travel party size of three or more is also prevalent, especially on Sundays. This suggests a potentially large market for a transport policy which is aimed at increasing PT use for group travel, such as the FFS, making the evaluation of the impact of FFS important to provide evidence supporting interventions for sustainable choices.

Figure 1 Proportion of joint household travel by travel party size in Sydney



Data source: Sydney HTS 2007/08 - 2009/10.

Comparing travel behaviour in a repeated cross-sectional survey in two different time periods requires that households in the two samples are equally representative. Table 1 compares the sample distribution of households in the before and after periods of the FFS policy in terms of household characteristics and the household's spatial setting. Statistical tests (independent samples t-test for mean comparison and non-parametric test for median) suggest that the distribution of households in the before and after samples are quite similar, reflecting the random sampling method of the Sydney HTS. However, households in the after sample have, on average, significantly less drivers and lower income than those households in the before period. This may due to the global financial crisis 2009 and a decreasing trend in licence-holding among young people in Sydney (Raimond and Milthorpe, 2010). Differences might also be because the Sydney HTS defines representativeness over a year period which this comparison split into two parts. The differences in median household income and average licence holders may favour a higher propensity of PT use amongst households during the after period and thus, the differences must be controlled for to not overestimate the success of the FFS policy.

Table 1 Comparison of households in the before and after samples

Statistic	Before	After	p-value
Mean percentage of couple household with no children	22%	21%	.500
Mean percentage of household with young children	44%	41%	.169
Mean household size	3.27	3.28	.789
Mean number of cars	1.60	1.62	.535
Mean number of licence holders	2.04	1.94	*.007*
Mean rail density	.10	.10	.590
Mean walking distance to closest high freq bus stop (km)	1.05	1.23	.065
Mean opportunity density around home ('000s/km^2)	.60	.62	.778
Mean pseudo node density ('000s/km^2)	1.52	1.63	.075
Mean street link density ('000s/km^2)	.11	.11	*.007*
Median household income ('000$ in 2006)	90.19	77.56	*.001*
Sample size (households)	**1,388**	**1,664**	**N/A**

Data source: Sydney HTS 2007/08 - 2009/10, households surveyed on Sundays.

Table 2 Statistical tests of FFS effect on changes to travel behaviour on Sundays

KPI	Sample	Before	After	Statistical test	p-value
PT demand: Proportion of PT tours to motorised tours	Eligible households	5.7%	4.9%	Independent sample t-test	.727
	All households	6.3%	9.5%		.078
Switching travel behaviour: Share of joint PT tours to total PT tours	Eligible households	47.8%	11.8%	Chi-squared	.187
	All households	28.8%	26.8%		.850
Mode shift to PT: Share of PT mode for joint travel	Eligible households	2.5%	0.7%	Chi-squared	*.033*
	All households	2.6%	2.8%		.872
Multimodal use: Share of multimodal PT tours to total PT tours	Eligible households	4.5%	11.8%	Chi-squared	.570
	All households	9.6%	14.8%		.436
Distance travelled: Median distance travelled of joint tours by PT (km)	Eligible households	44.5	20.7	Non-parametric	.103
	All households	44.5	14.7		.163

Data source: Sydney HTS 2007/08 – 2009/10.

Table 2 shows the results of statistical tests of the effect of FFS discounts on changes to travel behaviour on Sundays. Different KPIs in Table 2 present the potential impacts of the FFS policy on PT demand, switching travel pattern between individual and joint travel, modal shift to PT, multimodal use and distance travelled. These potential impacts are tested by comparing travel behaviour of households before and after the implementation of the FFS tickets in terms of the performance indicators. Two ways of forming the samples are used, one selects eligible households only and the other uses all households. Households with at least one adult and one child under 16 or school student up to 18 years of age (i.e. eligible households) are the target population of the FFS policy and thus an evaluation based on their travel behaviour is more relevant. However, considering the possibility of group travel with non-household members and a loose enforcement of the FFS rules in terms of the relationship between travellers, tests with all households are warranted.

Comparing the proportion of PT tours to total motorised tours generated by eligible households before (5.7%) and after (4.9%) the introduction of FFS tickets shows no statistically significant difference. A similar test based on the sample of all households also leads to the same conclusion, although the level of significance is better (lower p-value). Chi-squared tests reveal no significant impacts of the group travel discounted fares on a shift in travel patterns (from individual to joint), travel mode (from car to PT) and multimodal use (single PT mode to multiple PT modes) for group travel. The only significant change is that eligible households are *less* likely to use PT for joint travel, which is opposite to expectations since FFS tickets exist to offer them a cheaper option. Confounding factors such as car ownership, land use patterns, and travel party size may explain this observation. Whilst an improved segmentation analysis by these factors using multi-dimensional cross-tabs may control for the effect of confounding factors, this could not be done with the small size of the current dataset. The next section uses multivariate analysis to take account of the effect of the FFS tickets and confounding factors on mode choice.

5. Multivariate analysis

Table 3 shows the distribution of home-based tours by group travel and travel mode in the sample. Public transport share is about 6% of total tours on Sundays in Sydney with group travel being much less likely to be PT-based. This is due to a number of factors. First, the main segments of PT use in Sydney are work and education and these are less likely to be present in weekend travel. Second, the marginal cost of having an additional person in a car is nearly zero, compared to PT which requires an additional ticket. This highlights the importance of having discounted tickets to encourage PT use for group travel.

Table 3 Distribution of home-based tours by group travel and travel mode on Sundays

	All travel		Individual travel		Group travel	
	N	%	N	%	N	%
PT	141	6	102	9	39	3
Car	2,391	94	989	91	1,402	97
Total	2,532	100	1,091	100	1,441	100

Data source: Sydney HTS 2007/08 – 2009/10, households surveyed on Sundays.

Table 4 shows the estimation results of a nested logit model for the choice of travel pattern and main travel mode, estimated by NLOGIT 5. The individual choice of main travel mode is formulated conditioned on the choice of travel pattern between individual and group travel. No constants are specified for the group travel and the car alternatives as they are used as the reference cases for choice of travel pattern and travel mode, respectively. The behavioural aspects of this modelling framework are discussed in more detail in Ho and Mulley (2013c). Normalising one logsum parameter of the individual travel nest as one, the estimated logsum parameter of the group travel nest (0.679) lies significantly between zero and one, indicating that the model is consistent with random utility maximising theory. The McFadden adjusted R-squared is 0.248, suggesting a relatively good fit of the model to the data.

In addition to the household and individual characteristics, the model controls for the impact of the level of service (travel time and costs), travel purposes, land use variables (rail density, street layout, and distance to high frequency bus stop), tour complexity and various transport-related fringe benefits in evaluating the impact of the FFS policy on travel mode. Not all of these potentially confounding factors are shown to be a significant influence on travel mode choice. Variables with insignificant estimates are removed from the final model shown in Table 4 unless their estimates have important policy implications and the expected sign.

Table 4 Estimation results (t-stat) of Nested Logit model for mode choice of group and individual travel on Sundays

Variable	Group travel	Individual travel
Model for choice of travel pattern (individual vs. group)		
Mother of mixed aged children (aged 0-5 & 6 - 16)	1.097 (2.96)	
Father of mixed aged children (aged 0-5 & 6 - 16)	0.562 (1.49)	
Household with children under 15 years old	0.744 (6.79)	
Household with 5 or more persons	-0.253 (-2.10)	
Children aged up to 5 years		-1.900 (-4.82)
Children aged 6 - 10 years		-1.061 (-3.13)
Maintenance tour		-3.119 (-8.18)
Discretionary tour		-3.747 (-9.82)
Constant		2.396 (6.02)
Model for choice of travel mode (PT vs. car)		
Travel cost (2008$), generic	-0.123 (-7.76)	-0.123 (-7.76)
Travel time (minute), generic	-0.018 (-2.60)	-0.018 (-2.60)
Wait time (minute), generic	-0.028 (-4.84)	-0.028 (-4.84)
Public transport		
Eligible travel group, after the launch of FFS	0.093 (0.18)	
Non-eligible travel group, after the launch of FFS	1.577 (2.94)	
Non-eligible travel group, before the launch of FFS	1.196 (1.88)	
No-car household	2.264 (3.89)	2.756 (7.35)
Household with fewer cars than drivers	0.444 (1.06)	0.642 (1.76)
Household income (10k $)	-0.043 (-1.44)	-0.014 (-0.60)
Fuel costs provided		-2.992 (-2.79)
Student over 15 years old		0.999 (3.14)
Multiple purposes at single destination tour	0.646 (2.44)	
Multiple purposes at multiple destinations tour	-0.313 (-0.93)	
Rail kernel density, Destination	0.527 (1.96)	1.372 (5.75)
Street density ('000s/km^2), Destination	4.355 (3.16)	2.454 (2.29)
Pseudo nodes density ('000s/km^2), Home		-0.275 (-2.36)
Constant	-2.484 (-2.75)	-0.667 (-1.56)
Car		
Licence holder	0.861 (3.24)	1.840 (6.82)
Inclusive value parameter	0.679 (4.74)	1 (Fixed)
Number of tours	2,532	
Log likelihood at convergence	-1,536	
Pseudo R-squared adjusted (vs. zeros)	0.553	
Pseudo R-squared adjusted (vs. constants)	0.248	

Data source: Sydney HTS 2007/08 – 2009/10, households surveyed on Sundays.

5.1 Effect of the FFS fare discounts

The effect of the FFS discounts on mode choice for group travel is evaluated through a set of dummy variables created by interacting the travel group composition and the period indicator (reflecting the before and after nature of this evaluation). The set contains three dummy variables: ‘eligible travel group, after’, ‘non-eligible travel group, before’ and ‘non-eligible travel group, after', with the reference being the 'eligible travelling group, before'. In Table 4, the parameter associated with the variable 'eligible travel group, after the launch of FFS' is interpreted as the additional utility derived from PT by a travelling group eligible for FFS tickets, as compared to the reference of the before period when the FFS tickets have not been introduced. This parameter indicates the effect of the FFS discounts on travel mode choice of eligible travel groups, controlling for impacts of confounding factors. The parameter is positive but not significant, suggesting that the model detects no significant change to travel mode choice for group travel due to the introduction of the discounted fares of the FFS ticket. Using a likelihood ratio test, the parameter estimates of the non-eligible travelling groups before (1.196) and after (1.577) are not statistically different at the 5% level (p = 0.246), indicating that the effect of confounding factors is successfully controlled for. In addition, these parameters are significantly positive, suggesting that even without financial incentives non-eligible travelling groups are more likely than eligible travelling groups to use PT. This is expected as eligible travelling group must involve at least one child and the literature suggests that PT is less preferred to car for travelling with children (Hensher and Reyes, 2000; Cicillo and Axhausen, 2002).

5.2 Other factors influencing mode choice on Sundays

Although the model in the above section was developed to evaluate the influence of introducing the FFS ticket on mode choice for joint travel on Sundays in Sydney, other modelling results are worthy of note, given the limited number of studies of Sunday travel behaviour reported in the literature (O'Fallon and Sullivan, 2003). The propensity to travel as a group on Sundays is highly associated with travel purpose, household and individual characteristics. These results are consistent with previous results reported in Ho and Mulley (2013c) where Saturdays and Sundays are combined. This suggests that mode choices on Sundays are not substantially different from that of Saturdays, although other travel behaviour such as travel generation and VKT may be different (O'Fallon and Sullivan, 2003).

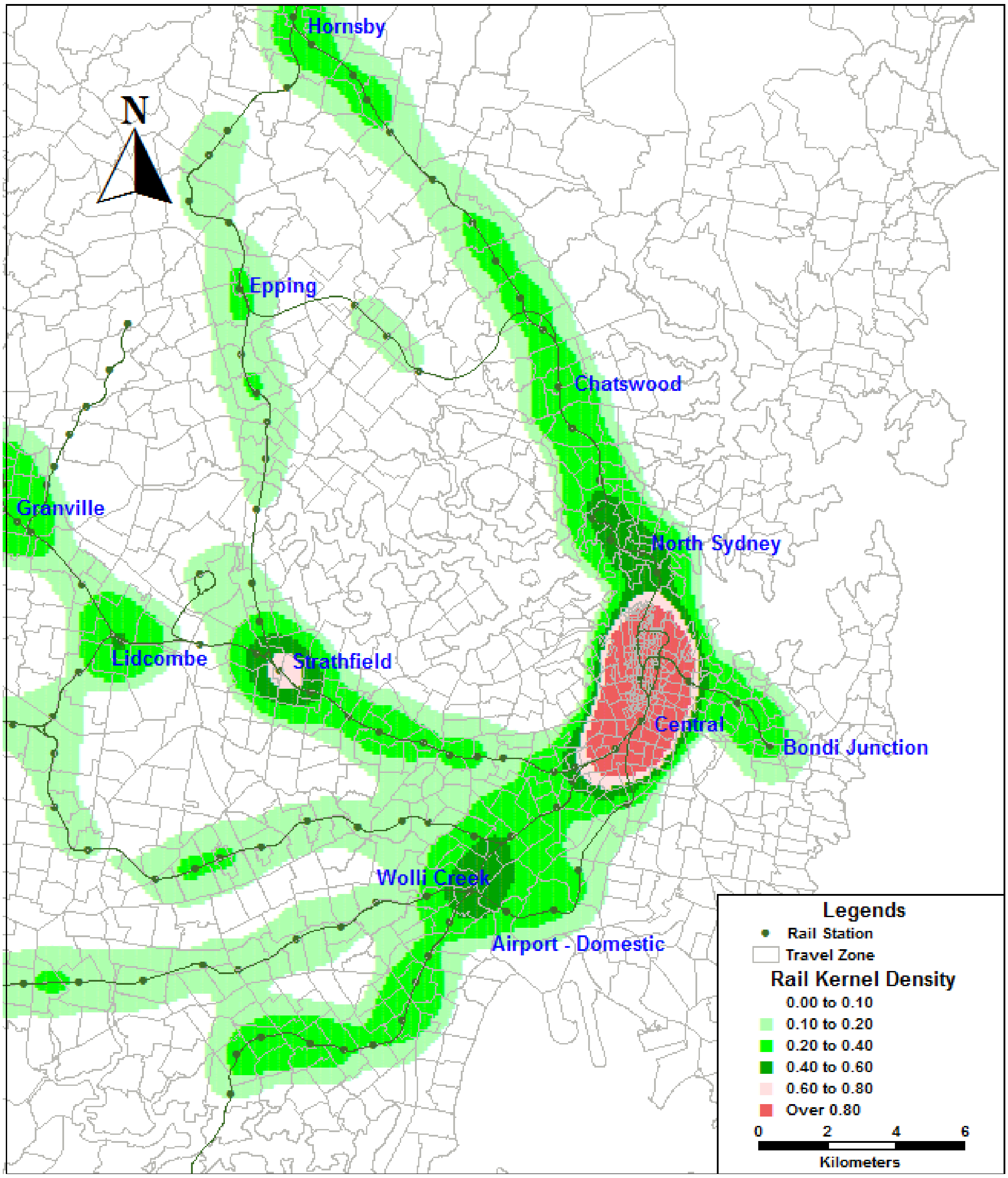
Most activities on weekend are for recreational, social and shopping purposes (Lockwood et al., 2005; Srinivasan and Bhat, 2008; Ho and Mulley, 2013c). The estimation results indicate these activities are more likely to be undertaken jointly than individually. This highlights the challenges of reducing traffic congestion from car use and increasing PT use on weekends as moving people out of their car is more difficult when they travel together.

The value of travel time (VOT) can be derived from the parameter estimates associated with travel time and travel costs. The model delivers the average VOT on Sundays of A$ 8.81 per person hour for in-vehicle time and A$13.69 for wait time. These VOTs have important policy implications. For example, assuming a travel group eligible for FFS tickets is faced with a choice of using a car with a saving of 10 minutes in-vehicle time for an otherwise 1-h journey (30 km) by PT. Assuming further that fuel consumption rate of the car is 10 litre/100km, the fuel price is $1.50 per litre, the parking cost is $4, and the cost of time spent finding parking equals to the cost of waiting time if using PT (i.e. saving of wait time equals $0). Taking account of VOT savings estimated above, a travel group of 2 persons without a child will incur a cost of $5.56 by car for this example journey, compared to $5.00 using the discount offered by a FFS ticket. Thus, discounts for group travel do provide PT with an economic comparative advantage so as to compete with the car. However, the relative advantage of PT mode with FFS tickets diminishes as the travel party size increases. A travel group of 3 persons for the above journey would cost $4.10 by using car but $7.50 if using PT.

Table 4 shows that on Sundays PT is mainly used by captive users who are students, holding no driving licence and by households without a car. Although households with fewer cars than drivers has a positive parameter suggesting a higher propensity to use PT than households with enough cars for drivers (the reference case), their estimated parameters are not statistically significant at the 5% level. This is realistic as weekend travel is oriented towards shared activities where household members typically travel together, and thus only one car is needed.

Land use patterns, especially at the destination, are found to have a significant impact on PT use on Sundays. The rail density (Figure 2), estimated using kernel density function weighted by the rail service frequency (see Ho and Mulley, 2013b), has a significantly positive impact on PT use. Similarly, a highly connected road network at the destination (shown by the variable street density in Table 4) is significantly associated with higher PT use.

Figure 2 Rail kernel density weighted by service frequency, central area of Sydney SD



Data sources: Developed from GIS layers.

6. Conclusions and discussion

This paper has evaluated the impact of the Family Funday Sunday (FFS) discounted tickets on changes to travel behaviour of the residents in Sydney. In the absence of longitudinal data, this paper has conducted an *ex post* evaluation of the FFS policy using data from the repeated cross-sectional Sydney Household Travel Surveys and a KPI measurement approach. Several potential effects of the FFS policy for group travel including the induced demand for public transport (PT), switching travel patterns from individual to joint travel, modal shift, distance travelled by PT, and the use of multiple PT modes for travel are explored through KPIs. Statistical tests and modelling analysis detect no significant changes to these aspects of travel behaviour before and after the implementation of the FFS tickets.

Group travel accounts for a substantial proportion of regional travel demand and can play an important role in the success or failure of any transport policy aiming to promote sustainable choices. This paper has highlighted the importance of providing PT with the opportunity to financially compete with the private car as a mode of travel. The insignificant effect of the FFS tickets on mode choice found in this paper does not necessarily imply a bleak outlook for an extension of group travel discounts being applied more widely. This finding may be due partly to the strict conditions on the travel party composition imposed by the FFS ticket which reduces the potential population to a minor segment (i.e. travelling with children) of the travelling public. Removing this condition would increase the target population to all travelling groups and may lead to changes to travel behaviour at a regional level to be observed. This is supported by the modelling approach used in this paper which suggests group travel, in general, is more likely to be made by car but groups not eligible for FFS tickets (i.e. not involving children) have a significantly higher propensity than eligible travelling groups to use PT on Sundays. However, it must be acknowledged that other factors such as carrying heavy shopping bags, travelling with pram and attitudes towards PT may prevent public response to the FFS program. Clearly the revenue impact of FFS is negligible but expanding such discounts to all group travel on Sundays (as with the new Opal ticket trials) or to other times of day or week will have important implications for revenue and requires further research.

As the statistical tests and model developed in this paper are based on a relatively small sample size, the results reported in this paper must be interpreted carefully. Finding no significant changes to travel behaviour does not necessarily mean the FFS tickets do not have any impact on travel behaviour. Rather, its impacts on travel behaviour may be small in statistical terms which require a large sample size to detect (Richardson et al., 2004; Stopher et al., 2009). Although the Ministry of Transport's Annual Report for the year 2008-2009 suggests a 39% increase in Sunday ferry patronage after the introduction of the FFS ticket, its effect on PT patronage as a whole may not be large (NSW, 2009, p. 9). This is because ferry accounts for a very minor proportion of total trips in Sydney (about 0.2% of total trips or 2% of total PT trips on an average weekday) and would attract more travellers under the FFS scheme than other PT modes as ferry is more popular for leisure travel and quite expensive without FFS discounts (BTS, 2013; NSW, 2013a). Future research needs to consider the differential effects that the group travel discounts have on the different PT modes.

A further investigation would identify whether people defer the day of their leisure activity, from Saturdays to Sundays, to take advantage of the FFS ticket. An insight into this switching effect could be achieved by examining changes to Saturday and Sunday travel before and after the implementation of the FFS policy. This would require the analysis of daily train patronage from the Ticketing Reporting System and bi-annual ferry load census data from Harbour City Ferries (BTS, 2013). Daily data sources for bus use would be important but may be not available until after the implementation of the smart card system. Analysing these daily data sources is challenging but the knowledge gained would be useful to inform policy aiming at spreading the peak and promoting PT use. For example, the existence and presence of crowding during weekday peak hours together with user preferences for less crowding will continue to be a barrier to increasing PT use (Hensher et al., 2011; Li and Hensher, 2011). If a switching effect can be observed then discounted fares for off-peak group travel on weekdays could reduce peak crowding.

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