RAND EUROPE

STM3 modelling school days only

James Fox, Bhanu Patruni

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Preface

RAND Europe was commissioned by the Bureau of Transport Statistics (BTS) of Transport for NSW to modify the Sydney Strategic Transport Model (STM) to reflect travel on an average school day rather than on an average workday. This change was made so that the model better reflected the highest levels of demand in the peak periods, particularly for public transport. This work was undertaken in late 2013, but this report was not made publicly available until 2015.

The STM was designed by Hague Consulting Group (1997). In Stage 1 of model development (1999–2000), Hague Consulting Group developed mode-destination and frequency models for commuting travel, as well as models of licence ownership and car ownership. In addition a forecasting system was developed incorporating these components. In Stage 2 of model development (2001–2002), RAND Europe, incorporating Hague Consulting Group, developed mode and destination and frequency models for the remaining home-based purposes, as well as for non-home-based business travel. Then, during 2003 and 2004, RAND Europe undertook a detailed validation of the performance of the Stage 1 and 2 models. Finally, Halcrow undertook Stage 3 of model development (2007), re-estimating the home–work mode-destination models, and at the same time developing models of access mode choice to train for home–work travel.

By 2009, some model parameters dated back to 1999, raising concerns that the model may no longer reflect with sufficient accuracy the current behaviour of residents of Sydney. Furthermore, changes to the zone structure of the model occurred with the number of zones approximately trebling in number and the area of coverage increased to include Newcastle and Wollongong. Therefore, the BTS commissioned RAND Europe to re-estimate the STM models using more recent information on the travel behaviour of Sydney residents, and implement those updated models. The updated version of the model system is referred to as STM3.

The work to modify STM3 to work with an average school day definition, rather than an average workday, was undertaken in late 2013. The change was made by modifying the travel frequency models to work with an average school day definition. No changes were made to the mode-destination models on the basis that the factors that impact upon mode and destination choice are not expected to vary significantly in and out of school term time.

This document is intended for a technical audience familiar with transport modelling terminology.

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For more information about RAND Europe or this document, please contact James Fox:

RAND Europe
Westbrook Centre
Milton Road
Cambridge CB4 1YG
United Kingdom
Tel. +44 (1223) 353 329
jfox@rand.org

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1. Introduction

BTS have decided that the Sydney Strategic Model (STM) should be revised to reflect travel on an average school day, rather than an average workday. This change will allow the model to better reflect the highest levels of demand in the peak periods.

In the 1999 to 2008 waves of HTS data used for model estimation, there were either 251 or 252 workdays each year, compared with between 194 and 201 school days. In Sydney, the school holidays are in:

- December/January – five weeks
- Easter – two weeks
- June/July – two weeks
- September/October – two weeks.

All of the development work undertaken on the STM3 model prior to late 2013 used the average workday definition, and the level of service is generated using assignments of average workday travel matrices, and therefore all of the parameters in the travel demand models are defined on an average workday basis. Significant differences in travel frequency would be expected in and out of school term time, both for school travel but for other travel purposes as well, and therefore the frequency models have been re-estimated in this work. However, the mode-destination models have not been re-estimated as it is believed that the factors that impact upon mode and destination choice will not vary significantly in and out of school term time.[1] The licence holding and car ownership models do not model day-to-day decisions and therefore it was judged that there is no reason to re-estimate these models using individuals sampled out of school term time.

BTS will apply the new school day only models using school day only base matrices. These will be generated using expanded HTS data, either by taking the school day records directly, or by using workday matrices adjusted to school day control totals. The latter approach aims to reduce the sparsity of the matrices. However, at the time of writing (late 2013) this work has not begun and therefore level of service measures are only available for travel on an average workday. As discussed above, BTS do not currently plan to re-estimate the STM3 mode-destination models once the new base matrices are

[1] Higher levels of demand in the peak periods would be expected in school term time, and this might be expected to have an impact on mode choice because of increased highway congestion. However, the impact of this effect is assumed to be small, and furthermore school day matrices are not currently available to allow school day level of service to be generated.

available, although the level of service used in application will change with the move to reflect an average school day.

Section 2 of this note presents analysis highlighting the impact of moving from the workday definition to the school day definition on tour and detour frequency rates. Section 3 summarises the work to re-estimate the frequency models to reflect the revised definition. Finally, Section 4 summarises the changes to the application system that have been made as a result of the changes to the frequency models, and presents validation of the tour and detour rates against expanded HTS data.

2. Frequency analysis

Table 1 summarises the impact of the revised average day definition on the home-based tour rates. It is noted that all school days are also workdays.

Table 1: Home-based tour rates

Purpose	Workday rate	School day rate	Change
home–work	0.502	0.515	2.5%
home–business	0.104	0.109	4.1%
home–primary education	0.719	0.892	24.1%
home–secondary education	0.665	0.824	24.0%
home–tertiary education	0.026	0.029	11.9%
home–shopping	0.177	0.168	-4.9%
home–other travel	0.615	0.616	0.0%

The tour frequency rates for education purposes show significant increases as expected. The increase is smaller for tertiary compared with primary and secondary as tertiary education terms are typically shorter than primary and secondary education terms because some of the university term is during school holiday periods. Furthermore, some students attend technical colleges that hold classes for most weeks of the year.

It is interesting to note that home–work and home–business tour rates also increase slightly when the samples are restricted to school days. It is probable that this reflects the fact that parents are more likely to take their leave outside of school term time. Thus in the peak periods in school term time there are more people commuting to work as well as more people travelling to and from school.

Home–shopping tour frequency rates are slightly lower in school term time, most likely reflecting the fact that more people are at work and studying, but there is little impact on the home–other travel tour frequency rate.

The changes to the non-home-based (NHB) tour rates are summarised in Table 2. The work–business tour rates are expressed as the number of business tours made per home–work tour. Separate detour models are estimated for business detours made in the course of tours to work and business primary destinations (PDs) and for outward and return tour leg detours. The detour rates are the rates of detour making per home–work or home–business tour.

Table 2: NHB tour rates

Purpose	Workday rate	School day rate	Change
work–business	0.097	0.097	-0.3%
business detours, PD work, outward leg	0.029	0.028	-4.2%
business detours, PD work, return leg	0.033	0.032	-3.1%
business detours, PD business, outward leg	0.243	0.249	2.7%
business detours, PD business, return leg	0.281	0.278	-1.3%

The work–business tour rate is essentially unchanged by the move to a school day definition. Three of the four detour rates decline slightly; it may be that during school term time some workers need to detour to school locations to drop or pick up children and this results in a slight drop in the detour rate to business locations.

3. Frequency results

In this chapter the frequency models estimated using the workday definition are referred to as the old models, whereas those estimated using the revised school day definition are referred to as the new models.

In the zero/one-plus sub-models, the parameters are placed on the zero tours alternative and therefore positive parameters mean that an individual is less likely to make tours. Similarly, in the stop/go sub-models, positive parameters mean that an individual is more likely to stop and so make fewer tours.

Table 7 presents the old and new commute frequency models. The majority of the parameters show a slight reduction in the level of significance in the new model, which is consistent with the 20 per cent reduction in the size of the estimation sample. The magnitude of the accessibility parameter has reduced, which indicates that either the logsums calculated from mode-destination parameters estimated using workday data give a worse explanation of school day behaviour, or that there is less variation in tour frequency on school days than on non-school days. The magnitude of the male constant in the zero/one-plus model increases with the move to a school day definition, which suggests that mothers reduce their work tour rates more than fathers during school term time.

Table 3: Commute frequency model results

Parameter	Description	Old model (17) Workdays		New model (19) School days	
Zero/one-plus sub-model:					
Constant	constant to ensure fraction making at least one tour replicated	-0.197	-1.4	-0.448	-2.9
FTed	full-time students less likely to make tours than full-time workers	2.149	21.7	2.205	19.8
PTed	part-time students less likely to make tours than full-time workers	1.605	11.7	1.724	11.4
PTwk	part-time workers less likely to make tours than full-time workers	0.692	11.1	0.760	10.8
caswk	causal workers less likely to make tours than full-time workers	0.883	10.7	0.891	9.5
volwk	voluntary workers less likely to make tours than full-time workers	1.663	11.4	1.728	11.0
ageo39	persons aged over 39 less likely to make tours than those aged up to 39	0.166	3.9	0.152	3.1

ageo59	persons aged over 59 less likely to make tours than those aged up to 59	0.313	4.0	0.306	3.5
carcompet	individuals in households with car competition make fewer tours	-0.238	-4.7	-0.184	-3.2
compcar	individuals in households with company cars make more tours	0.675	14.8	0.741	14.4
males	males less likely to make tours than females	0.526	12.1	0.631	12.7
manufac	individuals with manufacturing occupations make more tours	-0.697	-9.7	-0.676	-8.2
incpu20.8k	individuals with incomes under $20,800 p.a. make fewer tours	0.453	7.1	0.522	7.3
incge67.6k	individuals with incomes of $67,600 p.a. and above make more tours	-0.120	-2.3	-0.149	-2.5
access	individuals with higher accessibility make more tours	-0.133	-6.2	-0.119	-4.9
Stop/go sub-model:					
Constant2	constant to observed multiple tour making rate is replicated	3.396	34.0	3.309	31.2
compcar2	individuals in households with company cars make more multiple tours	-0.500	-3.4	-0.459	-2.9
manufac2	individuals with manufacturing occupations make fewer multiple tours	0.534	2.0	0.490	1.7
inpu20.8k2	individuals with incomes under $20,800 p.a. make more multiple tours	-0.410	-2.3	-0.477	-2.6
Inge 67.6k2	individuals with incomes of $67,600 p.a. and above make fewer multiple tours	0.490	2.5	0.563	2.7

Table 4: Business frequency results

Parameter	Description	Old model (15) Workdays		New model (17) School days	
Zero/one-plus sub-model:					
noneASC	constant to ensure fraction making at least one tour replicated	8.198	19.3	7.936	18.5
zerocrs0	individuals in zero car households make fewer tours	0.299	2.3	0.312	2.2
carcomp0	individuals in households with car competition make fewer tours	0.158	3.0	0.144	2.5
cmpcar0	individuals in households with company cars make more tours	-0.882	-19.9	-0.942	-19.1
manual0	individuals with manual occupations make many more tours than non-workers	-6.113	-14.8	-5.913	-14.3
nonmanual0	individuals with non-manual occupations make many more tours than non-workers	-4.720	-11.5	-4.507	-10.9
manu0	individuals with manufacturing occupations make fewer tours	1.237	16.8	1.217	15.0
FTst_pens0	full-time students and pensioners make fewer tours	0.939	6.7	0.990	6.3
male0	males more likely to make tours than females	-0.898	-19.4	-0.906	-17.7
age<24_0	individuals aged up to 24 make fewer tours	0.445	6.6	0.472	6.2
lsm0	individuals with higher accessibility make more tours	-0.121	-4.6	-0.114	-4.0
Stop/go sub-model:					
stopASC	constant to observed multiple tour making rate is replicated	2.545	27.1	2.552	24.7
cmpcarpl	individuals in households with company cars make more multiple tours	-0.478	-4.4	-0.481	-4.1
age<24pl	individuals aged up to 24 make fewer multiple tours	0.632	3.0	0.631	2.7
incu31.2	individuals with incomes under $31,200 p.a. make more multiple tours	-0.460	-4.0	-0.541	-4.4

As per the commute results, the magnitude of the accessibility term has reduced somewhat in the new model. However, in contrast to the commute model, the magnitude of the male term in the zero/one-plus model shows little change with the move from a workday to a school day definition.

Table 5: Primary education frequency results

Parameter	Description	Old model (11) Weekdays		New model (13) School days	
Zero/one-plus sub-model:					
noneASC	constant to ensure fraction making at least one tour replicated	-0.220	-0.8	-1.285	-2.9
spec0	children attending special schools make fewer tours	1.241	3.4	1.997	4.9
hinc<25k0	individuals from households with incomes under $25,000 p.a. make fewer tours	0.329	4.0	0.179	1.3
lsm0	individuals with higher accessibility make more tours	-0.128	-2.8	-0.139	-1.9
Stop/go sub-model:					
stopASC	constant to observed multiple tour making rate is replicated	5.269	22.9	5.264	22.9

In the primary education frequency model results, the constant on zero tours has increased in magnitude (more negative) reflecting the high tour frequency rate on school days. Although the accessibility term has reduced in significance, the magnitude of the parameter has actually increased indicating a larger accessibility effect.

Table 6: Secondary education frequency results

Parameter	Description	Old model (14) Workdays		New model (16) School days	
Zero/one-plus sub-model:					
noneASC	constant to ensure fraction making at least one tour replicated	-0.756	-18.3	-1.702	-28.6
age>15_0	persons aged over 15 make fewer tours	0.318	4.3	0.612	6.3
Stop/go sub-model:					
stopASC	constant to observed multiple tour making rate is replicated	5.955	2.7	5.962	2.7
lsmpl	individuals with higher accessibility make more multiple tours	-0.138	-0.6	-0.138	-0.6

As per the primary education model there is a large change to the constant in the zero/one-plus sub-model, but unlike primary education the accessibility parameter is more or less unchanged.

Table 7: Tertiary education frequency results

Parameter	Description	Old model (20) Workdays		New model (22) School days	
Zero/one-plus sub-model:					
noneASC	constant to ensure fraction making at least one tour replicated	5.050	16.3	4.491	13.9
FlTmSt_0	full-time students make more tours than other adult categories	-3.556	-19.2	-3.635	-18.6
FlTmWk_0	full-time workers make more tours than other adult categories	0.548	2.3	0.506	2.0
Uni_0	university students make fewer tours than other education types	-0.467	-2.9	-0.382	-2.2
PInc>15.6k	individuals with personal incomes over $15,600 p.a. make fewer tours	0.687	4.7	0.816	5.2
age1518_0	individuals aged 15-18 make more tours than older individuals	-0.769	-4.0	-0.709	-3.3
lsm0	individuals with higher accessibility make more tours	-0.120	-2.3	-0.062	-1.1
Stop/go sub-model:					
stopASC	constant to observed multiple tour making rate is replicated	9.126	3.5	9.342	3.4
lsmpl	individuals with higher accessibility make more multiple tours	-0.861	-2.2	-0.898	-2.2

In the tertiary education frequency model results the accessibility parameter in the zero/one-plus sub-model has decreased noticeably in magnitude in the new model.

Table 8: Shopping frequency results

Parameter	Description	Old model (16) Workdays		New model (18) School days	
Zero/one-plus model:					
noneASC	constant to ensure fraction making at least one tour replicated	1.855	32.0	1.906	28.7
FTstu_0	full-time students make fewer tours	0.485	7.4	0.607	7.9
PTstu_0	part-time students make fewer tours	0.219	2.4	0.289	2.8
FTwkr_0	full-time workers make substantially fewer tours	0.965	23.3	1.011	21.4
unempl_0	unemployed persons make more tours	-0.356	-4.7	-0.340	-3.9
lookhm_0	people looking after the home make more tours	-0.403	-10.7	-0.418	-9.8
lic_0	licence holders make more tours	-0.359	-8.4	-0.363	-7.4
0_1cars_0	individuals in households with zero or one tour make more tours	-0.179	-6.2	-0.179	-5.3
compcr_0	individuals in households with car competition make fewer tours	0.158	4.7	0.165	4.3
age<10_0	children aged under 10 make fewer tours	1.379	11.0	1.167	7.3
age<15_0	children aged under 15 make fewer tours	1.197	12.8	1.552	12.9
age>29_0	individuals aged over 29 make more tours	-0.352	-8.5	-0.375	-7.8
PerInc>26k	individuals with incomes > $26,000 p.a. make fewer tours	0.152	3.9	0.155	3.6
male_0	males make fewer tours	0.116	4.1	0.096	3.0
lsm0	individuals with higher accessibility make more tours	-0.108	-7.5	-0.105	-6.4
Stop/go model:					
stopASC	constant to observed multiple tour making rate is replicated	2.661	25.7	2.661	22.3
lsmpl	individuals with higher accessibility make more multiple tours	-0.212	-5.5	-0.207	-4.7

In the shopping frequency results, the magnitudes of the parameters show only modest changes, consistent with the smaller change in the tour frequency rate compared with the education purposes.

Table 9: Other travel model parameters

Parameter	Description	Old model (17) Workdays		New model (19) School days	
Zero/one-plus model:					
noneASC	constant to ensure fraction making at least one tour is replicated	0.579	14.1	0.693	14.9
FlTmSt_0	full-time students make fewer tours	0.340	8.4	0.329	7.2
FlTmWk_0	full-time workers make substantially fewer tours	1.063	33.9	1.040	29.5
PtTmWk_0	part-time workers make fewer tours	0.246	5.9	0.163	3.5
unempl_0	unemployed persons make more tours	-0.440	-6.1	-0.588	-7.2
lookhm_0	people looking after the home make more tours	-0.254	-6.9	-0.409	-9.8
retired_0	retired persons make more tours	-0.128	-3.3	-0.255	-5.9
lic_0	licence holders make more tours	-0.301	-9.8	-0.385	-11.1
free1lic_0	individuals in households with one licence holder and free car use make more tours	-0.159	-4.9	-0.164	-4.5
2pcars_0	individuals in households with two or more cars make more tours	-0.063	-3.0	-0.074	-3.1
hinc>104k0	individuals with incomes of $104,000 p.a. and above make more tours	-0.074	-3.4	-0.085	-3.5
0kids_0	individuals in households with no children make fewer tours	0.394	15.7	0.436	15.4
1kid_0	individuals in households with one child make fewer tours	0.152	5.4	0.146	4.6
lsm0	individuals with higher accessibility make more tours	-0.238	-14.4	-0.240	-12.9
Stop/go model:					
stopASC	constant to observed multiple tour making rate is replicated	1.462	25.3	1.498	22.8
FlTmStPl	full-time students make fewer multiple tours	0.275	4.6	0.388	5.5
FlTmWkPl	full-time workers make fewer multiple tours	0.604	17.6	0.652	17.0
licpl	licence holders make more multiple tours	-0.681	-19.6	-0.772	-19.8
hinc>104kp	individuals with incomes $104,000 p.a. and above make more multiple tours	-0.117	-4.1	-0.081	-2.6
0kidspl	individuals from households without children make fewer multiple tours	0.488	16.6	0.528	16.2
3plkidspl	individuals from households with three or more children make more multiple tours	-0.271	-7.3	-0.304	-7.4
lsmpl	individuals with higher accessibility	-0.170	-7.2	-0.179	-6.7

	make more multiple tours		

For other travel frequency, the values of most of the parameters are similar in the new model, but there are exceptions, for example the retired persons term in the zero/one-plus model is stronger in the new model, and the multiple tour term for full-time students is larger (fewer tours) in the new model, which is a plausible change.

Table 10: Work-based business model parameters

Parameter	Description	Old model (6) Workdays		New model (8) School days	
Zero/one-plus model:					
noneASC	constant to ensure fraction making at least one tour replicated	4.071	22.7	4.023	20.7
compcar_0	individuals from households with company cars make more tours	-0.646	-6.2	-0.632	-5.5
FTwk_0	full-time workers make more tours	-0.388	-3.4	-0.431	-3.4
PI>41.6k_0	individuals with incomes ≥ $41,600 p.a. make more tours	-0.401	-3.0	-0.373	-2.5
HB_CarD_0	individuals who drive to work are more likely to make tours	-0.596	-4.4	-0.556	-3.8
male_0	males make more tours	-0.512	-4.8	-0.472	-4.0
CBD_0	tours are more likely to be made from workplaces in the CBD	-0.459	-2.9	-0.550	-3.2
Stop/go model:					
stopASC	constant to observed multiple tour making rate is replicated	1.647	6.9	1.721	6.5
HB_CarD_pl	individuals who drive to work are more likely to make multiple tours	-0.402	-1.5	-0.399	-1.4

There are no large changes to the work–business model parameters, which is consistent with the very small change to the overall tour rate.

Table 11: Business detour model PD business parameters

Parameter	Description	Old models (7 & 3) Workdays		New models (9 & 5) School days	
Outward detours:					
noneASC_OB	constant to ensure observed outward detour rate is replicated	1.979	9.9	1.832	8.7
PI<31.2kOB	individuals with personal incomes under $31,200 p.a. make fewer outward detours	0.383	2.2	0.473	2.5
HB_CarD_OB	individuals who drive to their business PD make more outward detours	-0.713	-4.1	-0.627	-3.4
male_OB	males make more outward detours	-0.351	-2.4	-0.322	-2.1
Return detours:					
noneASC_RB	constant to ensure observed return detour rate is replicated	1.594	9.1	1.675	8.7
compcar_RB	individuals from households with company cars make more return detours	-0.282	-2.6	-0.275	-2.3
HB_CarD_RB	individuals who drive to their business PD make more return detours	-0.471	-2.9	-0.548	-3.0
male_RB	males make more return detours	-0.141	-1.1	-0.139	-1.0

There are no large changes to the model parameters following the restriction of the estimation sample to school days only.

4. Base year validation

The travel demand (TravDem) models have been updated to use the new frequency model parameters, and the models have been re-run for the 2006 base year.

Table 12 compares the home-based tour rates observed in the unweighted sample of HTS tours used to estimate the frequency models with the tour rates calculated from a base year run of the updated TravDems. It is noted that the estimation tour rates include outward half tours as well as full tours, but not return half tours. Outward half tours have been included with equal weight to full tours in preference to including both outward and return half tours with a weight of 0.5 because return half tours are more likely to be subject to coding errors.

It is noted that the tour rates in the unweighted HTS data and the TravDems would not necessarily be expected to match exactly, as there will be cases where the expanded base population is a better representation of the true population than the unweighted HTS estimation sample. The travel demand (TravDem) models have been updated to use the new frequency model parameters, and the models have been re-run for the 2006 base year.

Table 13 compares the home-based tour rates observed in the unweighted sample of HTS tours used to estimate the frequency models to the tour rates calculated from a base year run of the updated TravDems (TDs). It is noted that the estimation tour rates include outward half tours as well as full tours, but not return half tours. Outward half tours have been included with equal weight to full tours in preference to including both outward and return half tours with a weight of 0.5 because return half tours are more likely to be subject to coding errors.

It is noted that the tour rates in the unweighted HTS data and the TravDems would not necessarily be expected to match exactly, as there will be cases where the expanded base population is a better representation of the true population than the unweighted HTS estimation sample.

Table 12: Home-based tour rate validation

	Workdays model			School days model		
	HTS	TD	diff.	HTS	TD	diff.
home–work	0.502	0.499	-0.5%	0.515	0.513	-0.3%
home–business	0.104	0.103	-0.5%	0.109	0.108	-1.1%
home–primary education	0.719	0.669	-7.0%	0.892	0.879	-1.5%
home–secondary education	0.665	0.648	-2.6%	0.824	0.801	-2.8%
home–tertiary education	0.026	0.027	4.5%	0.029	0.031	7.0%
home–shopping	0.177	0.178	0.8%	0.168	0.170	0.9%
home–other travel	0.615	0.609	-1.0%	0.616	0.607	-1.3%

Overall, the correspondence between the unweighted HTS and TravDem tour rates is consistent with that observed in the previous workday model. There is a closer correspondence between the unweighted HTS and TravDem tour rates for primary education in the revised school day model.

Table 13 compares the total number of tours predicted by the TravDems with the numbers observed in expanded 2004–2009 HTS data. The frequency and mode-destination models are estimated from unweighted HTS data, and the base year population predicted by the population synthesiser is the output from a series of models rather than an exact match to the base year population. Therefore, while the expanded HTS totals are the best available validation statistics and the TravDem numbers would be expected to be in line with them, an exact match between the HTS and TravDem numbers is not expected.

Table 13: Home-based tours validation

	Workdays model			School days model		
	HTS	TravDem	diff.	HTS	TravDem	diff.
home–work	1,522,669	1,559,138	2.4%	1,572,659	1,601,755	1.9%
home–business	423,825	428,800	1.2%	448,372	445,936	-0.5%
home–primary education	329,878	310,152	-6.0%	412,951	407,774	-1.3%
home–secondary education	266,897	244,129	-8.5%	331,258	302,019	-8.8%
home–tertiary education	103,566	106,637	3.0%	113,766	122,295	7.5%
home–shopping	930,090	915,773	-1.5%	865,783	871,319	0.6%
home–other travel	3,188,611	3,125,591	-2.0%	3,178,888	3,117,781	-1.9%
Total home-based tours	6,765,535	6,690,220	-1.1%	6,923,677	6,868,880	-0.8%

Home–primary education validates better against the HTS data in the school days model whereas the validation for home–tertiary education worsens. Overall there is a slight improvement in the validation of total home-based tours, which are closely matched to within 1 per cent of observed.

When the non-home-based (NHB) models were validated, larger differences were observed between the TravDem predictions and the expanded HTS data. These differences were observed with both the workday and school day definitions, as shown by Table 14.

Table 14: NHB tour and detour validation

	Workdays model			School days model		
	HTS	TravDem	Diff.	HTS	TravDem	Diff.
work–business	140,366	138,424	-1.4%	146,112	156,191	6.9%
business detours PD work, outward leg	42,413	41,661	-1.8%	41,804	38,854	-7.1%
business detours PD work, return leg	54,377	53,263	-2.0%	54,885	45,122	-17.8%
business detours PD business, outward leg	104,989	97,515	-7.1%	113,646	103,542	-8.9%
business detours PD business, return leg	121,047	118,113	-2.4%	126,733	121,348	-4.3%

Under the workday definition, the work–business model was recalibrated to HTS totals, but a slightly lower HTS total was used (138,457) which we believe excludes modes that are not modelled. No recalibration was undertaken of the business detour models under the workdays model because summing over all business detours, a good match was achieved to the lower HTS validation total (310,552 TravDem detours compared with 322,826).[2]

The NHB frequency models in the school days model have been recalibrated so that they match the HTS validation totals given in Table 14 exactly. Table 15 compares the NHB tour and detour rates after recalibration to the rates observed in the unweighted HTS estimation samples.

[2] Again, our understanding is that the difference is the exclusion of modes that are not modelled, but it is possible that the HTS weights have been revised.

Table 15: NHB tour and detour rate validation (after recalibration)

	Workdays model			School days model		
	HTS	TravDem	Diff.	HTS	TravDem	Diff.
work–business	0.097	0.089	-8.3%	0.097	0.098	1.3%
business detours PD work, outward leg	0.029	0.027	-7.3%	0.028	0.026	-5.7%
business detours PD work, return leg	0.243	0.229	-5.7%	0.249	0.257	3.1%
business detours PD business, outward leg	0.033	0.034	4.1%	0.032	0.034	7.4%
business detours PD business, return leg	0.281	0.278	-1.2%	0.278	0.286	3.1%

It can be seen that, in most cases, for the school days model higher tour and detour rates are necessary in application to match the weighted HTS data than were observed in the unweighted HTS estimation sample. In addition to the impact of weighting, these differences may relate to the fact that the NHB models were estimated from 1999–2008 HTS data, whereas the HTS validation totals are calculated from 2004–2009 HTS data. An increase in NHB tour and detour making between 1999–2008 and 2004–2009 would be consistent with the differences observed in Table 15.