CHANGES TO COMMUTE MODE: THE ROLE OF LIFE EVENTS, SPATIAL CONTEXT AND ENVIRONMENTAL ATTITUDE

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ABSTRACT

It has been suggested that commuting behaviours become resistant to change and that changes to commute mode may be more likely at the time of major life events. This paper presents for the first time a robust quantification of the effect of life events on the likelihood of changing commute mode, controlling for demographics, socio-economics, spatial context and environmental attitude. This is conducted for a large, representative sample of the English working population using data from the first two waves of the UK Household Longitudinal Study. Changes in commute mode are found to be most strongly associated with changes in distance to work which occur in association with moving home or changing job. The distance relationship is asymmetric with increases in distance being far more likely to prompt switches to car commuting than reductions in distance are to prompt switches to non-car commuting. Residential relocations that involve an increase in population density and reduced journey times to employment by public transport are found to increased likelihood of switching to non-car commuting. The results support a theoretical conception put forward in the paper of how travel behaviour is influenced by events over the life course and indicate there are opportunities for behavioural change interventions to be targeted at population groups experiencing life events.

1. INTRODUCTION

Local transport policies in urban areas are often concerned with encouraging people to adopt non-car transport in order to reduce pressure on scarce road space and to improve the quality of the urban environment. Policies are particularly targeted towards managing commuting behaviours, as it is during the morning and evening peak commuting times that transport networks are under the most pressure. However, it has been shown that daily car commuting becomes habitual and is repeated with little or no conscious consideration of alternatives (*1*). Habits are automatically repeated behaviours with little or no conscious reconsideration of whether alternative behaviours may be as, or more effective.

For this reason it is a challenge to encourage people to adopt new commuting behaviours, even if improvements are made to public transport services or to walking and cycling environments. Whilst there has been substantial research into the factors associated with commuting by different transport modes, there has been less attention given to identifying the factors associated with *changes* to commute mode. However, it is important to understand these factors if effective policies and measures are to be developed to influence commuting behaviours. The 'habit-discontinuity hypothesis' posits that habits may become weakened when routine behaviours, such as commuting, are interrupted by a contextual change (*2*). It can be expected that people are more likely to change commuting mode if there is a contextual change to their life situation (life event) or to external situational factors (*3*). In this paper we:

1. Review existing knowledge on how life events and other factors influence the mode of transport used by individuals to get to work; and
2. Use national panel data for England to identify the role of life events, spatial context and environmental attitude in workers changing their commute mode.

The paper begins with the review which clarifies the knowledge gaps and intended contributions of our study. We then put forward a framework for analysing changes in commuting behaviours, describe the data used for our analysis and present results. The paper finishes with a discussion of the implications of the results for research and policy.

2. LITERATURE REVIEW

The main focus of the review is on longitudinal studies that have investigated factors associated with *changes* to commute mode choices, but we start by discussing mode choice models that have been developed from cross-sectional data to explain commute mode choices since these are useful in setting out factors that are considered to influence commute mode choices.

2.1 Determinants of commute mode choice

Mode choice models are usually underpinned by a utility maximising framework in which travellers are assumed to evaluate the attributes of transport modes available to them for the journey they are undertaking and choose the option that provides the greatest overall utility. Travel times and costs are the attributes usually included in mode choice models with sometimes additional attributes such as reliability included. Demographic and socio-economic characteristics (e.g. gender, income) are included as explanatory variables in mode choice models to recognise that tendencies to use modes may vary in the population. After including modal attributes and trip maker characteristics in mode choice models, there are

usually unexplained preferences for particular modes and these are represented by alternative specific constants in the utility function.

Recent work has sought to explain differences in individual mode preferences by incorporating subjective variables relating to perceptions and attitudes in mode choice models. For example, Johansson et al (*4*) found for a sample of workers commuting between Uppsala and Stockholm in Sweden that attitudes towards flexibility and comfort, as well as pro-environmental inclination, influenced their mode choices. These were additional to the influence of modal time and cost.

Urban planners have an interest in how urban form influences travel behaviour and have looked more broadly at the influence of the built environment on commute mode choices than merely though their impact upon travel times and costs. They have shown that commute mode choice can also be influenced by land use density, mix and design (*5*). A study by Dalton et al (*6*) is an example of a study that considered a wide range of built environment characteristics. They analysed a data set of commuters living in Cambridge (n=1124) to identify which neighbourhood, route and workplace related environmental characteristics influence mode choice. Those working in areas with fewer destinations were less likely to use public transport or cycle, whilst the availability of free parking at the workplace was associated with lower odds of using public transport, cycling or walking. The distance to work strongly predicted walking and cycling and the models indicated that the odds of walking and cycling were 3.9 and 1.3 times lower for each additional km. With respect to the structure of the transport network, the authors report that "low junction density (indicating poor street connectivity) and a greater distance to a railway station were associated with lower odds of walking, cycling, and public transport use. A greater distance to the nearest bus stop and a lower bus frequency were associated with lower odds of public transport use."

The question has been raised, however, as to whether built environment has a causal influence on commute mode choice or whether people self-select into residential neighbourhoods that suit their pre-existing commute mode preference. Studies that have sought to distinguish between the effect of attitudes towards travel and the effect of built environment have tended to confirm that both are important with built environment exerting an independent effect, after controlling for measures of attitudinal self-selection (*7*). Potentially, longitudinal studies that track commuting behaviour and individual circumstances (including life events such as residential moves) over time can shed further light on causal influences of commute mode choices and we now turn to these.

2.2 Determinants of changes to commute mode choice

We now review longitudinal studies of commuting behaviour that have identified determinants of changes to commuting mode. A study by Panter et al (*8*) identified predictors of changes in commuting mode occurring over a 12 month interval for a sample of 655 workers in Cambridge. The predictors tested were measured at baseline and reflected factors (demographic, socio-economic, attitudinal, built environment) found to be relevant in cross-sectional studies. They found uptake of alternatives to the car was associated with being older, having a degree, convenient cycle routes and a lack of free workplace parking. They found increased walking to work was associated with not having children, convenient public transport and a lack of free workplace parking. Increased cycling to work was predicted by convenient cycle routes and more frequent bus services. The study did not test the influence of change variables for events occurring in people's lives or external situational factors.

The role of life events

Dargay and Hanly (*9*) showed through a descriptive analysis of the British Household Panel Survey (n~5,000) that 17.6% of surveyed commuters changed mode between years. A bivariate analysis indicated that 14.0% of those who do not move home and do not change employer change commute mode, but this increases to 28.1% for those who move home, 32.7% for those that change employer and 44.6% for those that change both home and employer. This confirms susceptibility to these events for commute mode and is particularly significant when recognising that 8.3% of survey sample moved home between any pair of years, 9.3% changed employer and 2.0% changed both home and employer. While this study shows that commuting mode is more likely to change at the time of these life events, other factors have not been controlled for in these bivariate examples.

Oakil et al (*10*) is the only identified multiple regression analysis of the relationship between a full range of life events and commute mode changes using a retrospective survey capturing 21 year event histories for 200 respondents in the Utrecht region (Netherlands). Shifts from commuting by car were associated with switching to part time work, changing employer, and separation from a partner (1 year before the shift). Shifts to commuting by car were associated with the birth of the first child, changing employer, and separation (1 year before the shift). After controlling for other factors, residential relocations were not significant (though this may be confounded by separation effects). Data limitations prevented an examination of spatial context however.

Verplanken et al (*2*) studied the effect of residential relocations on the commuting mode of 433 university employees and found employees who had moved within the last year and were environmentally concerned used the car less frequently than environmentally concerned commuters who had not moved within the last year. They suggest that the contextual change allows environmentally concerned individuals to adjust their commuting behaviour in line with their values.

Walker et al (*11*) investigated how the relocation of a workplace to a site with restricted parking availability affected commuting mode choices and habits among affected staff. There was a large increase in train use (19% to 56%) and reduction in car use (55% to 23%) after the move. Habit strength was shown to weaken amongst both commute mode changers and non-changers and new commuting habits were shown to grow, but remain relatively weak in the weeks following the move. This indicates that people may be susceptible to reverting to prior commuting behaviours following a contextual change. Walker et al also identified that measures of pre-move habit strength, age, children and consideration of post-move travel *failed* to predict commute mode changes in a logistic regression. The only significant factor was level of environmental concern. They speculate that spatial context factors which were omitted from their models were likely to be of greater importance.

Qualitative studies provide deeper insights into the process of changing commuting behaviour in adjustment to a residential relocation. People are shown to differ in the extent to which they plan travel, including the journey to work during the moving process and are not fully aware of transport opportunities until after the move. Jones and Ogilvie (*12*), argue that the notion of residential self-selection is consequently too deterministic. Stanbridge and Lyons (*13*) identified that travel is considered at different stages in the moving process and in particular when ‘selecting areas to search’, as a ‘prompt for the move’ and ‘after some time in the new house’. Qualitative accounts also reveal that people may follow a process of ‘trial and error’ adaptation to the new location, in which alternative commuting options are tried out until a satisfactory travel routine is established. This process can continue for several years after the move (*12, 14*).

Another body of work has examined how commuting influences the likelihood of home or job moves. For example, Clark et al (*15*) found (using Puget Sound Transportation Panel

data over the years 1989-1997) that both one-worker and two-worker households more frequently decrease commute distance and time, or it stays the same, than increase it when they move home (accompanied by job change or not). They develop a model which indicates a critical value of 8 km as the commute distance beyond which the likelihood of decreasing commute distance increases rapidly. This emphasises that it needs to be recognised that homes and job changes are not strictly exogenous but may be motivated by a wish to reduce the distance or time spent commuting, or use a particular mode of transport for the commute.

Changes to transport system

Changes to characteristics of the transport system are expected to influence commute mode choices (based on the concept of utility maximisation) and indeed are implemented for this purpose. Monitoring studies are often conducted to assess change in transport mode usage at an aggregate level after transport system interventions. These often show that there is a gradual response to an intervention with full impacts taking some time to be apparent (*16*). Few monitoring studies collect longitudinal data on individual travellers that can be used to confirm travellers react as anticipated to changes in the relative utilities of transport modes. A few exceptions are now considered.

Bradley (*17*) reported on mode choice modelling he conducted looking at the effect on mode choice of a new rail commuter line in the Netherlands. Before and after panel data for 475 commuters collected a year apart showed that 119 of the 475 car and bus commuters switched to the train. Bradley tested a dynamic model specification for the mode choice after the new line opened which accounted for the utility before and after the line opening. This showed that utilities in both periods were significant and demonstrates that the commuters had responded to the change in transport options but not completely adjusted to them at the time of the after survey. This suggests that commuters respond to a change in the transport system but not always instantaneously – one reason for a delay in response could be that residents are triggered to act when events occur in their lives that prompt them to think about travel conditions and options. To our knowledge no studies have been conducted that have considered the role of life events in how travellers respond to a change in the transport system.

Information and marketing interventions

As well as transport system changes, current transport policy is interested in the potential for information and marketing measures to influence transport mode choices. Tornblad et al (*18*) tested the impact of tailored information accompanied by a free seven-day public transport pass on 498 commuters in Lillestrøm, Norway, and found no significant effect on commuting by car in the short run (five weeks after) and medium run (five months after).

In contrast, Thøgersen (*19*) evaluated the impact of a free one month public transport card on 373 car owners in Copenhagen and found that it led to a significant increase in public transport use of commuters during the intervention period from 5% to 10%. Five months after the intervention public transport use stayed higher at 7% and more positive beliefs about public transport use were evident. Thøgersen suggested the intervention could be more effective if targeted at people undergoing changes in their lives and referred to research by Bamberg et al (*20*) who investigated changes in car use of people moving home to Stuttgart, Germany. Half of the subjects in this study were given a public transport information pack (including a free day ticket) and half were not given the pack. They found from comparing behaviour before the move and six weeks after the move that for both sets of participants the change in decision context caused the subjects to re-evaluate their behaviour. As expected,

the participants receiving the pack changed more to public transport use after the move (19% to 47% compared to 19% to 24%). This indicates that an intervention timed to coincide with a major life event can achieve a desired shift in travel behaviour.

3. KNOWLEDGE GAPS AND STUDY CONTRIBUTION

Studies of the impact of life events have shown that changes in commuting mode are more likely when life events occur and that spatial context and attitudes play a role at these occasions. Studies of the impact of transport interventions (system changes or information and marketing) have shown that changes in commuting mode occur but that responsiveness depends on individual circumstances. This indicates the value of investigating further the role of life events.

The novel contribution of this study is to develop models for the probability of changing commute mode that consider a *full range* of life events, at the same time as comprehensively controlling for demographics and socio-economics, environmental attitudes, spatial context and, importantly, changes in the distance to work. Such comprehensive models have not been possible to date owing to panel data constraints and a new opportunity to *rigorously* address this evidence gap arose following the initiation of a new large scale UK Household Panel Study in 2009 (described in Section 5). The study also contributes to the development of *theory of travel behaviour change*, by empirically examining relationships put forward in the conceptual framework now described.

4. RESEARCH FRAMEWORK

Our generalised conceptual model for the relationship between life events and travel behaviour is shown in Figure 1. The hypothesis made is that travel behaviour changes are triggered by a contextual change (a life event for the purposes of our research but this could also be a transport intervention). Life events can alter the roles that people perform within their family and social networks, alter the values people hold, alter the resources available for travel and alter the context for travel. These can create 'transport stressors', which entail discrepancies between the current transport circumstances and a desirable alternative *(21)* and can change the travel mode alternatives that are available, the characteristics of travel that are considered salient and hence attitudes towards transport modes *(22).* Three types of mediating factor are hypothesised to play a role in the outcome on travel behaviour of contextual change. These are personal history (for example, experience in using travel modes), intrinsic motivations (for example, saving money or improving health) and facilitating conditions (for example, public transport availability).

In the context of commute mode changes, life events are most likely to alter the origin/destination or the length of the journey to work, and/or the transport options that are available to serve the journey to work. They can also alter broader activity needs and schedules which can affect attitudes towards transport modes. We also acknowledge that life events themselves can be partly induced by transport considerations (such as a long commute). Figure 1 shows that 'transport stressors' can act to cause life events, as well as life events acting to cause 'transport stressors'. This relationship is not directly explored in this paper (given data limitations) but recognition is given to it in interpreting the results. The method and results of our study are now reported.

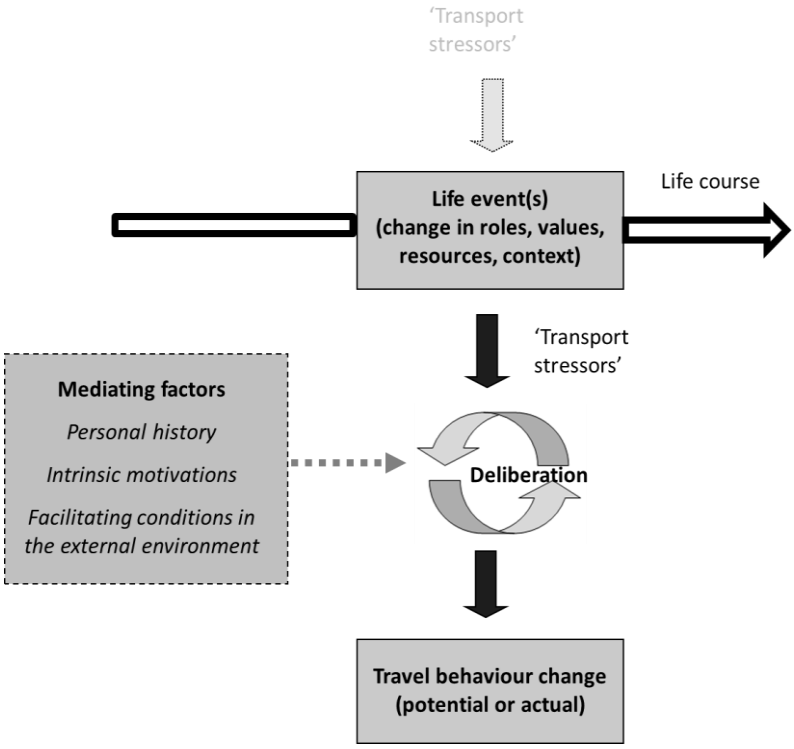

FIGURE 1 Conceptual model for explaining turning points in travel behaviour.

5. MODELS OF CHANGING COMMUTE MODE

5.1 UKHLS Data and Analytical Approach

The analysis of factors associated with changing commute mode from year to year was conducted using the first two waves of data available from the UKHLS (UK Household Longitudinal Study). UKHLS uses a sample that is representative of the UK population in 2009. It captures a range of social, economic and attitudinal information about the lives of members of 40,000 households. Adult household members (aged 16 or over) are interviewed once per year. Given restrictions in the availability of geographical context variables for all nations of the UK, the sample analysed was for individuals resident in England and that were in employment at both waves. This constituted 15,200 individuals.

Commuting modes

The UKHLS survey asks each employed person how they usually get to their place of work. The data confirmed the car as the most common method for travelling to work in England in 2009/10, providing transport for nearly two-thirds of those that were in employment. Walking and working from home were the next most commonly chosen options (Table 1).

TABLE 1 2009 commuting modal share for the English workforce.

Commute mode	Percentage of English workforce (weighted)	Unweighted sample counts / percentage	
		Frequency	Percent
Car (as driver or passenger)	64.2%	9561	62.9
Walk	10.0%	1621	10.7
Work from home	7.8%	1145	7.5
Bus/coach	5.4%	1014	6.7
Train	4.5%	679	4.5
Cycle	3.6%	478	3.1
Underground/light rail	2.7%	457	3.0
Other	1.7%	245	1.6
Total	**100.0%**	**15200**	**100.0**

Changing commute mode from year to year

3,056 (20%) of the 15,200 employees changed commuting mode by the following year. Table 2 shows, by mode, the percentage of people choosing the same or an alternative commuting mode by the following year. This shows that car commuting is a more stable option compared to other modes. It also illustrates how the car is the most attractive alternative to users of other modes. For example over 90% of car commuters were still commuting by car the following year. By contrast, a third of cyclists had changed to an alternative mode, with the largest share (16% of cyclists) switching to commuting by car.

A separate analysis of British Household Panel Survey (predecessor to UKHLS) data for 1991 – 2009 showed that the mean duration of car commuting (among the 4,098 respondents who participants in all 18 waves) was 6.3 years, while for public transport commuting it was 3.0 years and active commuting (commuting by walking or cycling) was 3.2 years. This highlights that people do not maintain non-car commuting for very long and once they start commuting by car, they are likely to remain a car commuting for a considerable length of time.

TABLE 2 People choosing the same/new commute mode by the following year, by mode.

	%age of people choosing each commute mode by 2010/11							
Commute mode in 2009/10	**Car**	**Walk**	**WFH**	**Bus/coach**	**Train**	**Cycle**	**Metro**	**Other**
Car	91.4%	2.5%	2.1%	1.1%	1.0%	0.6%	0.3%	1.0%
Walk	13.3%	76.1%	1.5%	4.6%	1.3%	1.6%	0.5%	1.0%
WFH	26.5%	3.5%	62.4%	0.8%	3.0%	0.6%	1.0%	2.3%
Bus/coach	16.6%	8.4%	1.1%	65.8%	2.7%	1.7%	2.5%	1.4%
Train	9.3%	2.9%	2.7%	5.7%	70.7%	1.0%	6.6%	1.0%
Cycle	16.3%	9.0%	0.8%	1.7%	1.9%	67.4%	1.0%	1.9%
Metro	6.8%	2.0%	2.4%	8.3%	13.1%	1.5%	64.3%	1.5%
Other	29.4%	10.6%	4.1%	2.4%	4.5%	3.3%	2.9%	42.9%

Analysis of changes to commuting mode

The substantive analysis focussed on identifying factors (including life events and spatial context) associated with *commuting by car* (driving or getting a lift) and *changes to and from* this position and factors associated with *commuting by active travel* (walking and cycling, herein referred to as active commuting) and *changes to and from* this position. There is major policy interest in the UK in encouraging commuting by alternatives to the car and in particular by active travel modes for those whom this is feasible.

These commuting behaviours were analysed through a two-step regression approach. In step one a *cross-sectional model* was estimated, on the full wave one sample, to identify factors associated with the commuting states of interest; namely: car commuting and active commuting. In step two, transition models were estimated for the commute mode changes of interest (to/from car commuting; to/from active commuting). The transition models were estimated on the appropriate subsample i.e. switching from car commuting is applicable only to those individuals that were commuting by car in wave one. For each employee there was one observation (continue to use the same mode at wave 2 or change mode), so there is no need to account for within-person serial correlation in observations. The dependent variables for each model are described in Table 3.

TABLE 3 Dependent variable descriptive statistics.

	Wave one		Changing mode by wave two	
Variable	**n**	**%**	**n**	**%**
Commute by car	9432	63.03	812	8.6
Commute by non-car	5532	36.97	916	16.6
Total	**14964**	**100**		
Commute by Active Travel	2070	13.83	465	22.5
Commute by non-Active Travel	12894	86.17	519	4.0
Total	**14964**	**100**		

Notes: sample counts have been adjusted for missing values in the explanatory variables used in the regression models

Binary logistic regressions were employed for both the cross-sectional models and the transition models. The dependent variables take the value '1' for the outcome of interest (commuting by car or active travel or changing to or from these positions) or '0' otherwise. Baseline variables for individual characteristics at wave one are included in the cross-sectional models and the commute mode change models. The transition models also include life events and a number of other *change* variables to capture changes in circumstance by wave two. With more waves of data available it would be possible consider longer term dynamics of commuting behaviour (such as lags and leads of commute mode changes in relation to life events).

Explanatory Variables – Baseline

The baseline variables include indicators of travel behaviour, distance to work, environmental attitude, household composition, socio-economic status and the geographical context in which the individual resides. The geographical context variables were drawn from other neighbourhood level data sets and linked to UKHLS via a geographic identifier - the UK census Lower Layer Super Output Area (LSOA). These linked variables are summarised in Table 4.

TABLE 4 Geographic context variables.

Neighbourhood variable	Source data set	Definition
Settlement type (London & Metropolitan, Other urban, Rural)	UK National Travel Survey categories	Degree of urbanity of area of residence
Population density	UK Census 2001	Population density in area of residence
Proportion of population economically active	UK Census 2001	-
Travel time to the nearest employment centre with at least 100 jobs by PT/Walk (mins)	DfT accessibility indicators 2009	Time taken by public transport to reach closest employment centre
Number of employment centres with at least 100 jobs accessible by PT/walk (weighted by distance decay function)	DfT accessibility indicators 2009	Ease of access by public transport to major employment opportunities
Travel time to nearest town centre by PT/walk (mins)	DfT accessibility indicators 2009	Time taken by public transport to reach closest commercial centre
Number of food stores accessible by PT/walk (weighted by distance decay function)	DfT accessibility indicators 2009	Ease of access by public transport to food shops (indicator of mixed land use)
Overall Index of Multiple Deprivation (IMD)	Indices of Multiple Deprivation 2010	Overall level of social deprivation
Living environment IMD	Indices of Multiple Deprivation 2010	Index combining measures of poor quality housing, numbers of road casualties and air pollution
Presence of railway station in LSOA or surrounding LSOA	National Public Transport Data Repository	-
No. of bus stops in LSOA	National Public Transport Data Repository	-

Note: All variables measured at Lower Layer Super Output Area level (typically population of 1500), except population density measured at Medium Layer Super Output Area level (typically population of 7000)

Distance to work was only collected during the first six months of the wave one survey (owing to having to shorten the UKHLS interview during wave one). Models were also estimated on the work-distance subsample (n=4,288) as a robustness check for the preferred (full sample) model results.

Environmental attitude was measured in the base year as a binary response to the statement "any changes I make to help the environment need to fit in with my lifestyle" (agreement or disagreement).

Explanatory Variables – Life events and other change variables

Continuous change variables: A number of continuous difference variables were included to capture changes in geographic context (such as an increase in number of local bus stops/ increase in population density) and change in household income between waves one and two. Note that a change in geographic context could only occur in association with a residential relocation as the geographic context variables were statically defined as a baseline measure.

Change in distance to work: Given that the work distance variable included a large number of missing values in wave one, it was necessary to code change in work distance as a categorical variable (including missing as a category to retain all observations). A single distance change threshold was defined for each commute mode switch. Sensitivity tests indicated that changes from 3 miles or over to below 3 miles most strongly predicted switches to non-car and to active commuting, while changes from 2 miles or less to over 2

miles most strongly predicted switches to car and non-active commuting. These distance change thresholds were used in the preferred models.

Life events: Dummy variables were coded for the range of life events summarised in Table 5. Employment changes were the most frequently experienced events followed by residential relocations. For each life event subsample, Table 5 also reports the percentage of individuals that experienced different commute mode changes. This may be compared to the proportion of commute mode changers for the full sample of interest (shown in bold in the first row of Table 5 to identify whether the life event is associated with increased prevalence of commute mode change.

TABLE 5 Percentage of commuters changing commute mode in association with life events.

	Full sample		Car to non-car		Non-car to car		Active to non-active		Non-active to active	
	n	%[a]	n	%[c]	n	%[c]	n	%[c]	n	%[c]
Full sample	**14964**	**100.0**	**9432[b]**	**8.6**	**5532[b]**	**16.6**	**2070[b]**	**22.5**	**12894[b]**	**4.0**
Life event sub samples										
Switched employer	1576	10.5	971	*18.2	605	*30.3	192	*59.4	1384	*8.7
Residential relocation	1012	6.8	590	*15.1	422	*23.0	178	*38.2	834	*7.9
Had child	578	3.9	368	9.2	210	20.5	80	26.3	498	3.2
Acquired driving licence	281	1.9	72	*15.3	209	*34.9	73	*52.1	208	*6.7
Started cohabiting	278	1.9	176	*14.2	102	**22.6	42	*35.7	236	5.5
Stopped cohabiting	183	1.2	116	*15.5	67	14.9	25	16.0	158	*7.6

Notes:
a: % individuals experiencing the life event
b: size of wave one commute mode sub sample (car, non car, active or non-active)
c: % of individuals changing commute mode
*: life event subgroup has a higher/lower prevalence of commute mode change compared to sample average, significant at 95% level
**: significant at 90% level

The comparison indicates that, of the life events tested, residential relocations, employment switches and gaining a driving licence were most strongly associated with increased prevalence of changing commute mode to/from car/active commuting. It is also once again apparent that switching away from non-car and active commuting is far more prevalent than switching towards non-car or active commuting in association with a life event. For example, the majority of active commuters in the sample, nearly 60%, switched to non-active commuting when they changed employer. Having a child is not found to be significant although there may be longer term effects of this life event that are not observable in this two wave sample. For example, parents returning to work from maternity leave may adopt alternative commuting behaviours and a large proportion of these individuals are likely to be excluded from this two wave sample.

The regression models for car and active commuting are presented in Tables 6 and 7 respectively. Note that these tables also report descriptive statistics for all explanatory variables (counts and percentages for categorical variables and means and standard deviations for continuous variables).

TABLE 6 Logistic regression models of car commuting and switches to and from this.

Dependent variable:	Wave 1 Commute by car				Switch from car to non-car				Switch from non-car to car			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
LIFE EVENTS												
Residential relocation	1012	6.76			590	6.26	1.803	0.000	422	7.63	1.684	0.006
Change in number of bus stops in LSOA	0.01	3.94			0.01	3.11	1.003	0.812	0.02	5.05	0.992	0.441
Change in rail station proximity	0.00	0.15			0.00	0.15	0.982	0.942	0.00	0.16	0.584	0.071
Change in travel time to nearest employment centre by PT/walk (mins)	0.01	1.39			0.01	1.51	0.918	0.020	0.02	1.17	1.106	0.052
Change in no. of emp centres with 100+ jobs by PT/walk	-0.01	0.23			-0.01	0.24	0.934	0.786	0.00	0.22	0.956	0.888
Change in travel time to nearest town centre by PT/walk (mins)	0.01	1.39			0.02	2.96	1.035	0.058	0.02	2.96	0.996	0.858
Change in no. of foodstores accessible by PT/walk in LSOA	-0.01	0.27			-0.01	0.27	1.059	0.788	0.00	0.26	0.753	0.305
Change in MSOA population density	-0.10	7.59			0.01	6.20	1.017	0.007	-0.27	9.50	1.003	0.622
Had child	578	3.86			368	3.90	1.127	0.582	210	3.80	1.164	0.537
Starting cohabiting	278	1.86			176	1.87	1.092	0.760	102	1.84	1.559	0.211
Stopped cohabiting	183	1.22			116	1.23	2.317	0.008	67	1.21	0.748	0.533
Switched employer	1576	10.53			971	10.29	2.538	0.000	605	10.94	2.479	0.000
Acquired driving licence	281	1.88			72	0.76	0.369	0.015	209	3.78	16.649	0.000
Change in work distance: missing	10738	71.76			7256	76.93	1.656	0.000	3482	62.94	1.600	0.000
Change in work distance to: below 3 mi to non car, above 2 mi to car [ref: no]					141	1.60	9.155	0.000	292	5.28	30.179	0.000
Change in income	0.24	2.41			0.22	2.35	1.017	0.346	0.29	2.52	0.994	0.756
WAVE 1 BEHAVIOUR AND ATTITUDES												
No. of household cars	1.53	0.83	3.038	0.000	1.76	0.71	0.798	0.003	1.14	0.87	1.462	0.000
Driving licence availability	12634	84.43	10.207	0.000	8998	95.40	0.178	0.000	3636	65.73	5.647	0.000
Work distance: missing	10677	71.35	37.366	0.000								
Work distance: 2 to under 5 mi	913	6.10	44.248	0.000								
Work distance: 5 to under 10 mi	732	4.89	54.699	0.000								

Dependent variable:	Wave 1 Commute by car				Switch from car to non-car				Switch from non-car to car			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
Work distance: 10 to under 25 mi	699	4.67	63.879	0.000								
Work distance: 25+ mi [Ref: under 2 mi]	287	1.92	28.604	0.000								
Pro-environmental behaviour needs to fit in with lifestyle (yes)	7912	52.87	1.228	0.000	5143	54.53	0.755	0.002	2769	50.05	0.884	0.240
Pro-environmental behaviour needs to fit in with lifestyle (non response) [Ref: No]	2025	33.59	1.274	0.003	1203	12.75	0.993	0.957	822	14.86	1.017	0.913
WAVE 1 HOUSEHOLD STRUCTURE												
Hh size 1	1582	10.57	1.444	0.001	915	9.70	0.821	0.302	667	12.06	1.174	0.458
Hh size 3	3361	22.46	0.749	0.001	2174	23.05	0.966	0.807	1187	21.46	0.984	0.918
Hh size 4+ [Ref: Hhsize 2]	5326	35.59	0.609	0.000	3412	36.17	0.985	0.925	1914	34.60	0.842	0.332
Live with a partner	10703	71.52	0.982	0.804	7029	74.52	0.888	0.360	3674	66.41	1.303	0.084
Child present in the household	7025	46.95	1.696	0.000	4566	48.41	1.183	0.212	2459	44.45	1.126	0.438
WAVE 1 SOCIO-DEMOGRAPHIC												
Female	7963	53.21	1.177	0.002	5011	53.13	0.876	0.154	2952	53.36	0.752	0.006
16-24	1255	8.39	1.038	0.733	671	7.11	1.127	0.513	584	10.56	2.198	0.000
25-29	1422	9.50	1.298	0.006	846	8.97	0.893	0.480	576	10.41	1.796	0.001
30-44	5967	39.88	1.207	0.002	3861	40.94	0.823	0.063	2106	38.07	1.143	0.280
60 plus [Ref: 45-59]	1134	7.58	1.302	0.010	708	7.51	1.316	0.107	426	7.70	0.879	0.522
Monthly household income (£)	4.23	2.85	0.944	0.000	4.30	2.79	1.033	0.071	4.12	2.96	0.982	0.399
Degree	4603	30.76	0.551	0.000	2653	28.13	1.339	0.064	1950	35.25	0.495	0.000
Other higher	2025	13.53	0.793	0.020	1389	14.73	1.000	0.999	636	11.50	0.542	0.002
A level	3053	20.40	0.732	0.001	1990	21.10	1.158	0.334	1063	19.22	0.759	0.101
GCSE [Ref: Other or no qualification]	3155	21.08	0.827	0.030	2058	21.82	1.171	0.283	1097	19.83	0.758	0.094
Management & professional	6471	43.24	1.142	0.072	4303	45.62	1.009	0.943	2168	39.19	0.802	0.143
Intermediate	2111	14.11	0.918	0.303	1370	14.53	0.885	0.408	741	13.39	0.747	0.088
Small employers & own account	1383	9.24	0.760	0.007	707	0.00	1.681	0.001	676	12.22	1.279	0.156
Lower supervisory & technical [Ref: Semi-routine or unemployed]	1087	7.26	1.317	0.010	757	91.97	0.772	0.158	330	5.97	1.423	0.091
Full time employed	11013	73.60	1.235	0.001	7164	24.05	0.896	0.308	3849	69.58	1.018	0.884
WAVE 1 NEIGHBOURHOOD CONTEXT												
Area: Inner London	990	6.62	0.251	0.000	205	97.83	1.776	0.082	785	14.19	0.432	0.012

Dependent variable:	Wave 1 Commute by car				Switch from car to non-car				Switch from non-car to car			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
Area: Outer London	1644	10.99	0.386	0.000	759	91.95	1.138	0.544	885	16.00	0.590	0.040
Area: Metropolitan areas	2254	15.06	1.086	0.471	1471	84.40	0.718	0.084	783	14.15	1.357	0.198
Area: Large urban (250k+)	1665	11.13	1.027	0.827	1087	88.48	0.926	0.695	578	10.45	1.274	0.333
Area: Medium urban (25k-250k)	3894	26.02	0.939	0.529	2647	71.94	1.002	0.989	1247	22.54	1.376	0.130
Area: Small urban (10k-25k)	1100	7.35	0.982	0.877	783	91.70	0.923	0.681	317	5.73	1.750	0.026
Area: Very small urban (3k-10k) [Ref: rural]	772	5.16	0.833	0.170	548	94.19	1.061	0.778	224	4.05	1.297	0.339
Travel time to nearest employment centre by PT/walk (mins)	9.65	5.50	0.997	0.638	9.98	5.36	0.989	0.324	9.09	5.69	1.019	0.080
No. of emp centres with 100+ jobs by PT/walk	7.10	1.00	1.068	0.157	6.99	0.99	0.943	0.453	7.29	0.99	1.298	0.006
Travel time to nearest town centre by PT/walk (mins)	16.67	10.95	1.003	0.393	17.57	11.26	1.005	0.324	15.15	10.23	1.007	0.274
No. of foodstores accessible by PT/walk in LSOA	3.40	1.01	0.940	0.159	3.27	0.99	1.132	0.098	3.62	1.01	0.998	0.979
Rail station in LSOA or neighbouring LSOA	5234	34.98	0.891	0.035	3164	66.45	1.113	0.248	2070	37.42	0.850	0.136
Number of bus stops in LSOA	10.85	11.41	0.995	0.070	11.14	9.60	0.998	0.719	10.36	13.96	0.991	0.091
MSOA population density (persons/HA)	31.33	31.66	0.994	0.000	24.98	24.54	1.002	0.508	42.15	38.72	0.997	0.255
LSOA proportion economically active	0.64	0.09	3.250	0.004	0.65	0.09	0.596	0.453	0.63	0.10	1.680	0.509
Overall Index of Multiple Deprivation score	20.50	14.60	1.019	0.000	18.89	13.94	0.992	0.144	23.23	15.27	1.009	0.123
Living environment Index of Multiple Deprivation score	21.25	16.27	0.989	0.000	18.69	15.17	1.009	0.011	25.61	17.13	0.999	0.738
Ethnic minority boost sample household	1768	11.82	1.025	0.774	771	8.17	1.203	0.237	997	18.02	1.429	0.022
Constant			0.001	0.000			0.366	0.202			0.001	0.000
/lnsig2u			-0.405	0.000			-0.224	0.000			0.152	0.000
sigma_u			0.817	0.000			0.894	0.000			1.079	0.000
rho			0.169	0.000			0.195	0.000			0.261	0.000
n/%	**14964**	**100**			**9432**	**63.03**			**5532**	**36.97**		
Successes	**9432**	**63.03**			**812**	**8.6**			**916**	**16.6**		

Notes: Grey shading indicates significance at 95% level

TABLE 7 Logistic regression models of active commuting and switches to and from this.

Dependent variable:	Wave 1 commute by active travel				Change from active to non-active				Change from non-active to active			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
LIFE EVENTS												
Residential relocation	1012	6.8			178	8.6	2.007	0.018	834	6.5	1.717	0.002
Change in number of bus stops in LSOA	0.01	3.9			-0.10	7.4	0.997	0.848	0.03	3.1	1.003	0.818
Change in rail station proximity	0.00	0.2			-0.01	0.2	0.899	0.825	0.00	0.2	1.085	0.746
Change in travel time to nearest employment centre by PT/walk (mins)	0.01	1.4			0.03	1.1	1.377	0.001	0.01	1.4	0.933	0.076
Change in no. of emp centres with 100+ jobs by PT/walk	-0.01	0.2			0.00	0.2	1.521	0.415	-0.01	0.2	0.505	0.007
Change in travel time to nearest town centre by PT/walk (mins)	0.01	1.4			0.03	3.3	0.994	0.848	0.02	2.9	0.984	0.340
Change in no. of foodstores accessible by PT/walk in LSOA	-0.01	0.3			-0.01	0.3	0.538	0.206	-0.01	0.3	1.524	0.054
Change in MSOA population density	-0.10	7.6			-0.21	8.5	0.999	0.933	-0.08	7.4	1.005	0.307
Had child	578	3.9			80	3.9	0.761	0.480	498	3.9	0.743	0.295
Starting cohabiting	278	1.9			42	2.0	1.209	0.716	236	1.8	0.816	0.548
Stopped cohabiting	183	1.2			25	1.2	0.357	0.228	158	1.2	1.371	0.373
Switched employer	1576	10.5			192	9.3	11.050	0.000	1384	10.7	2.564	0.000
Acquired driving licence	281	1.9			73	3.5	7.421	0.000	208	1.6	0.567	0.071
Change in work distance: missing	10738	71.8			1627	78.6	1.321	0.172	9111	70.7	1.266	0.046
Change in work distance to: below 3 mi to active, above 2 mi to non-active [ref: no]					41	2.0	31.364	0.000	184	1.4	4.674	0.000
Change in income	0.24	2.4			0.26	2.2	1.026	0.463	0.24	2.4	0.977	0.358
BEHAVIOUR AND ATTITUDES												
No. of household cars	1.53	0.8	0.515	0.000	1.08	0.8	1.234	0.083	1.60	0.8	0.655	0.000
Driving licence availability	12634	84.4	0.305	0.000	1248	60.3	2.161	0.000	11386	88.3	0.428	0.000
Work distance: missing	10677	71.4	0.745	0.002								
Work distance: 2 to under 5 mi	913	6.1	0.590	0.000								
Work distance: 5 to under 10 mi	732	4.9	0.157	0.000								
Work distance: 10 to under 25 mi	699	4.7	0.024	0.000								
Work distance: 25+ mi [Ref: under 2 mi]	287	1.9	0.000	0.995								

Dependent variable:	Wave 1 commute by active travel				Change from active to non-active				Change from non-active to active			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
Pro-environmental behaviour needs to fit in with lifestyle (yes)	7912	52.9	0.775	0.000	1030	49.8	1.006	0.969	6882	53.4	0.796	0.036
Pro-environmental behaviour needs to fit in with lifestyle (non response) [Ref: No]	2025	13.5	0.710	0.001	288	13.9	1.484	0.099	1737	13.5	1.150	0.329
WAVE 1 HOUSEHOLD STRUCTURE												
Hh size 1	1582	10.6	0.762	0.035	226	10.9	0.862	0.646	1356	10.5	0.950	0.800
Hh size 3	3361	22.5	1.337	0.005	464	22.4	0.986	0.956	2897	22.5	0.839	0.287
Hh size 4+ [Ref: Hhsize 2]	5326	35.6	1.641	0.000	749	36.2	0.803	0.432	4577	35.5	1.152	0.409
Live with a partner	10703	71.5	1.018	0.837	1329	64.2	0.904	0.638	9374	72.7	1.012	0.933
Child present in the household	7025	47.0	0.763	0.006	977	47.2	1.185	0.476	6048	46.9	1.199	0.228
WAVE 1 SOCIO-DEMOGRAPHIC												
Female	7963	53.2	1.044	0.505	1232	59.5	0.871	0.396	6731	52.2	1.055	0.613
16-24	1255	8.4	0.916	0.476	267	12.9	4.054	0.000	988	7.7	1.116	0.567
25-29	1422	9.5	0.806	0.059	215	10.4	2.210	0.008	1207	9.4	1.041	0.817
30-44	5967	39.9	0.883	0.103	770	37.2	1.477	0.052	5197	40.3	0.859	0.215
60 plus [Ref: 45-59]	1134	7.6	0.645	0.001	122	5.9	0.799	0.569	1012	7.9	0.727	0.165
Monthly household income (£)	4.23	2.9	0.991	0.515	3.63	2.4	0.994	0.868	4.33	2.9	0.953	0.067
Degree	4603	30.8	1.028	0.804	535	25.9	0.958	0.881	4068	31.6	1.062	0.743
Other higher	2025	13.5	1.020	0.866	240	11.6	0.878	0.673	1785	13.8	1.061	0.767
A level	3053	20.4	0.929	0.491	409	19.8	0.806	0.432	2644	20.5	1.211	0.267
GCSE [Ref: Other or no qualification]	3155	21.1	1.051	0.621	521	25.2	1.103	0.696	2634	20.4	1.233	0.206
Management & professional	6471	43.2	0.517	0.000	637	30.8	1.200	0.413	5834	45.3	0.697	0.011
Intermediate	2111	14.1	0.623	0.000	277	13.4	1.162	0.546	1834	14.2	0.737	0.054
Small employers & own account	1383	9.2	0.267	0.000	87	4.2	2.071	0.059	1296	10.1	0.867	0.444
Lower supervisory & technical [Ref: Semi-routine or unemployed]	1087	7.3	0.750	0.017	166	8.0	1.821	0.043	921	7.1	0.720	0.107
Full time employed	11013	73.6	0.697	0.000	1304	63.0	1.293	0.170	9709	75.3	0.715	0.004
WAVE 1 NEIGHBOURHOOD CONTEXT												
Area: Inner London	990	6.6	0.656	0.056	183	8.8	1.674	0.340	807	6.3	0.541	0.072
Area: Outer London	1644	11.0	0.697	0.037	166	8.0	1.514	0.346	1478	11.5	0.643	0.092
Area: Metropolitan areas	2254	15.1	1.001	0.996	319	15.4	1.237	0.590	1935	15.0	0.802	0.331

Dependent variable:	Wave 1 commute by active travel				Change from active to non-active				Change from non-active to active			
Name	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z	n/mean	%/SD	Odds ratio	P>z
Area: Large urban (250k+)	1665	11.1	1.415	0.026	276	13.3	1.189	0.670	1389	10.8	0.888	0.617
Area: Medium urban (25k-250k)	3894	26.0	1.602	0.000	645	31.2	0.921	0.814	3249	25.2	1.257	0.233
Area: Small urban (10k-25k)	1100	7.4	1.442	0.017	160	7.7	1.345	0.455	940	7.3	1.085	0.732
Area: Very small urban (3k-10k) [Ref: rural]	772	5.2	1.453	0.029	97	4.7	1.032	0.944	675	5.2	0.877	0.652
Travel time to nearest employment centre by PT/walk (mins)	9.65	5.5	0.980	0.022	8.67	4.2	1.026	0.263	9.81	5.7	0.985	0.270
No. of emp centres with 100+ jobs by PT/walk	7.10	1.0	0.723	0.000	7.22	1.0	1.521	0.006	7.08	1.0	0.915	0.342
Travel time to nearest town centre by PT/walk (mins)	16.67	11.0	0.993	0.071	14.86	10.1	1.015	0.144	16.97	11.0	1.005	0.442
No. of foodstores accessible by PT/walk in LSOA	3.40	1.0	1.265	0.000	3.67	1.0	0.830	0.184	3.36	1.0	1.223	0.020
Rail station in LSOA or neighbouring LSOA	5234	35.0	1.020	0.773	745	36.0	1.186	0.323	4489	34.8	1.054	0.631
Number of bus stops in LSOA	10.85	11.4	1.008	0.003	11.17	16.8	0.999	0.834	10.80	10.3	1.006	0.157
MSOA population density (persons/HA)	31.33	31.7	1.005	0.002	37.66	34.2	0.999	0.739	30.31	31.1	1.002	0.441
LSOA proportion economically active	0.64	0.1	0.339	0.031	0.63	0.1	3.269	0.336	0.65	0.1	0.291	0.108
Overall Index of Multiple Deprivation score	20.50	14.6	0.982	0.000	23.83	15.7	1.008	0.356	19.96	14.3	0.988	0.040
Living environment Index of Multiple Deprivation score	21.25	16.3	1.014	0.000	25.63	17.6	0.995	0.419	20.54	15.9	1.010	0.010
Ethnic minority boost sample household	1768	11.8	0.674	0.000	257	12.4	1.939	0.010	1511	11.7	0.826	0.253
Constant			21.356	0.000			0.001	0.000			0.299	0.187
/lnsig2u			0.253	0.000			0.593	0.000			-0.604	0.000
sigma_u			1.135	0.000			1.345	0.000			0.739	0.000
rho			0.281	0.000			0.355	0.000			0.142	0.000
n/%	**14964**	**100**			**2070**	**100**			**12894**	**100**		
Successes	**2070**	**13.8**			**465**	**22.5**			**519**	**4.0**		

Notes: Grey shading indicates significance at 95% level

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5.2 Regression Analysis: Car commuting and switches to/from this

Predictors of commuting by car

Before examining changes to/from car commuting the cross-sectional model is examined first to identify factors associated with commuting by car in wave one. C**ar use opportunity** and **distance to work** have the strongest effects. Having a driving licence and greater access to cars increases the likelihood of commuting by car. Commuting by car increases in likelihood as the distance to work increases, but only up to 25 miles, after which rail competes with car. The **residential context** has a strong effect with living in areas with greater access to alternatives to the car (London, higher population density, proximity to rail, poorer living environment – associated with main roads) reducing likelihood of commuting by car. Living in areas of higher deprivation is also associated with higher likelihood of car commuting. This may be because such locations have poorer public transport connectivity to employment.

After accounting for other factors, **higher economic status,** as indicated by educational qualifications and income, is associated with reduced likelihood of car commuting. One possible explanation for this is higher status jobs being located in larger urban areas that are less accessible by car. Self-employed and those working for small employers are less likely to commute by car (as they have a tendency to work from home) and those in lower supervisory and technical roles have increased likelihood of commuting by car. **Gender and life-stage** are relevant with the likelihood of car commuting greater for females, having children present in the household and being 25-44 or 60+ (after accounting for other factors such as car access and distance to work). This suggests that those with caring and household responsibilities prefer to use a car. **Attitudes** are found to play a role with willingness to act to protect the environment associated with lower likelihood of car use.

Predictors of switching to/from commuting by car

The transition models indicate that a **change in distance to work** most strongly predicts switching to/from car commuting. The distance-commute mode relationship appears to be asymmetric, with increases in distances having a stronger effect than reductions in distance e.g. an increase from 2 miles or less to at least 2 miles increases the likelihood of switching to car by 30 times, while a decrease from 3 miles or more to less than 3 miles increases likelihood of switching to non-car commuting by only 9 times.

Such changes occur either when moving home or changing employer (or both). These are frequently experienced, especially by younger adults, and are therefore of great significance for commuting. Residential relocations that involve an **increase in population density** and **reduced public transport travel times to employment centres** increase the likelihood of switching to non-car commuting, highlighting the importance of public transport availability/connectivity in reducing car commuting. Beyond these effects on journey distance and context, changing employer and moving home, as events in themselves, are associated with increased likelihood of changing to and from car commuting. This could be simply because they prompt deliberation about how to get to work which would not occur otherwise, but it may also be because they modify the attractiveness of commuting by different modes in ways that were not captured by the data (no information was available on transport attributes of the workplace).

Acquiring a driving licence is found to strongly predict a switch to car commuting – it is worth noting that a licence may be acquired with travel to work in mind. **Stopping cohabitating** increases likelihood of switching from car to non-car which reflects the loss of a car which will often occur in this circumstance. The results also show that workers in

different population groups and residential contexts have different propensities to switch to and from car commuting. **Those aged 16-29 are more likely than other age groups to switch towards car commuting**, indicating that young adults tend to move towards car commuting in their early years in the labour force. On the other hand highly educated individuals are less likely to switch to car commuting, suggesting that they take on jobs and residential locations that do not suit car commuting (whether this is willingly or not is not known). **Willingness to act to protect the environment** increases likelihood of switching from car to non-car, but is not found to affect the opposite switch, which suggests that attitude plays an active role for car commuters considering alternatives.

5.3 Regression Analysis: Active commuting and switches to/from this

Predictors of active commuting

The cross-sectional model confirms that many of the factors that predict car/non-car commuting also predict active/non-active commuting. In this section we identify how these attributes are similar or different to those found to be associated with car commuting.

In common with car commuting, **distance to work** and **car use opportunity** have the strongest effects. Active commuting is most likely for those living within two miles of work and the likelihood reduces for those within 2-5 miles (0.6 times the likelihood of those within 2 miles) and drops sharply for longer distances. Having a driving licence and greater access to cars reduces the likelihood of active commuting.

The **residential context** has a strong effect, but different characteristics play a role than with car commuting. Living in **mixed land use areas** (higher population density, close proximity to food stores, not close to large employment centres, poorer living environment - associated with main roads) and good access to bus services (more bus stops, shorter public transport journey times to employment) increase likelihood of active commuting. Access to a local rail station (which reduces likelihood of car commuting) does not have an effect. This suggests that the nature of the local built environment is important to active commuting. The result that higher deprivation is associated with lower likelihood of active commuting may arise due to such locations being poorly connected to employment sites and/or social groups living in these areas not being positive towards walking and cycling. Active commuting is more likely in non-metropolitan urban areas than metropolitan areas (including London) and rural areas after considering other factors such as distance to work and car ownership.

In contrast to car commuting, education level, income and gender are not important, but **employment type** is found to have a stronger effect. Those working in higher categories of employment (e.g. management roles) and those working for small employers or in self-employment are less likely to commute by active travel. The **attitude** relationship is as expected with **willingness to act to protect the environment** associated with increased likelihood of active commuting.

Predictors of switching to/from active commuting

The life events identified as important for switching to/from car commuting also hold for switching to/from active commuting. Employment changes and residential relocations that alter the **distance to work** are the strongest predictor of switches to and from active commuting. The asymmetric relationship is once again confirmed. An increase from 2 miles or less to at least 2 miles increases the likelihood of switching to non-active travel by 31 times, while a decrease from 3 miles or more to less than 3 miles increases likelihood of

switching to active travel by only 5 times. This suggests that active commuting is very unlikely to be sustained when the distance to work increases beyond 2 miles.

In comparison to switches to non-car commuting, different residential context changes are found to predict switches to active travel. Starting active commuting is more likely in association with **moves to mixed land use areas** (indicated by more food stores and fewer large employment centres), while switching to non-car commuting was associated with reduced public transport times to employment. The results also show that workers in different population groups and spatial contexts have different propensities to switch to and from active commuting. In contrast to switches to/from car commuting, education level is not found to be important but employment type is important. Those in management / professional jobs are less likely to begin active commuting than other employment categories. Consistent with switches to/from car commuting, younger adults aged 16-29 are more likely than other age groups to curtail active commuting. It is found that **willingness to act to protect the environment** increases likelihood of starting active commuting, but it is not found to affect the opposite switch. This suggests that attitude plays a role for those considering active commuting.

6. DISCUSSION

Empirical insights

Life events relating to employment changes and residential relocations are found to increase the likelihood of commute mode changes occurring. These changes are primarily driven by altering the distance to work, with distance increases being more likely to prompt initiation of car commuting (odds increased by a factor of 30) than distance reductions are to prompt initiation of active commuting (odds increased by a factor of 5). The employment change and relocation events also have an independent effect after controlling for distance to work changes, indicating that people are generally reconsidering their commuting options at these times and supporting the notion that habits weaken around the time of life events.

Our cross-sectional socio-demographic relationships were on the whole consistent with previous studies. There has been less evidence of their association with commute mode *changes* and in this respect we have confirmed Panter et al's (*8*) finding that certain socio-demographic characteristics also increase likelihood of particular commute mode changes. In particular holding a degree reduces likelihood of switching to car commuting, self-employment increases likelihood of switching to non-car (working from home), being a manager reduces likelihood of switching to active travel while those in lower supervisory or technical roles are more likely to switch to non-active travel. This highlights that different employment roles and locations promote different types of commuting behaviour changes.

The cross-sectional *spatial context* relationships were similarly consistent with previous studies. However, we have demonstrated for the first time that different types of change to spatial context encourage certain types of commute mode switching. Specifically moves to mixed land use areas (indicated by more food stores and fewer large employment sites) encourages switches to active commuting, while shorter journey times to employment by public transport encourages switches away from car commuting.

With respect to *attitudes*, the models indicate that a 'willingness to protect the environment' *precedes* a behavioural change towards non-car and active commuting, after controlling for socio-demographic characteristics. This attitude measure did not predict switches towards car commuting. This suggests that those considering changing to non-car commuting have environmental concerns and have deliberated on this prior to changing

behaviour. The temporal sequence also confirms that attitudes do not simply adjust to match new behaviours once they are established.

Theoretical contributions

Overall these empirical findings are supportive of the conceptual framework put forward in Figure 1. They show that life events relating to residential and employment location are associated with increased likelihood of commute mode changes. Factors relating to the built environment and pre-existing attitude orientations are shown to play a mediating role in this process. But it cannot be determined whether there was a wish to change commute mode prior to changing home or job, or whether the deliberation over commute mode only occurred afterwards. It is quite possible that reflection over commuting behaviour occurs both before and after. UKHLS asks for reason for residential relocations, but the options offered are very general (i.e. 'moved for employment reasons') and do not allow it to be understood whether a change in commute was a main factor.

Study limitations

What we have not been able to examine is the *longer term* relationships between life events, past experience and commute mode changes, given that only two waves of UKHLS data were available for analysis. We have not been able to look at whether commute mode changes tend to occur at the same as life events, or precede or follow them. Oakil et al (*14*) were able to examine this but their sample was relatively small and the results inconclusive. This is an area that would certainly benefit from further research as additional waves become available in UKLHS.

We have also not been able to examine the longer term trajectories of commuting with only two waves of data. It would be interesting to see whether duration of commuting by a particular mode affects likelihood of a switch taking place (with and without occurrence of life events). Past commuting behaviour is known to be a strong predictor of current behaviour (*13*), indicating that behaviours learnt in the past may exert a strong influence on how people adapt to new situations following life events. This could also be investigated with longer history data. More waves of data will also enable it to be examined whether relationships are stable over time or are specific to certain periods.

We only had information on life events experienced by our survey sample and not transport interventions. Ideally, data would be collected on both of these but this presents a challenging data collection requirement. However, combined data on both of these would allow the interaction between life events and transport interventions to be understood better.

Policy implications

Employment changes: The results showed that people are more open to change behaviour when they start working for a new employer. This implies that information and marketing measures (e.g. travel packs, temporary free bus passes) are likely to be most effective during recruitment and when new employees join an organisation. Such measures may be particularly appropriate for new, young adult entrants to the labour market given the earlier observation that young adults tend to move towards car commuting as their careers mature. Specific measures may also be targeted to particular employment roles given that these are shown to encourage specific types of commute mode changes.

Residential relocations: People are also more likely to change how they commute to work when they move home. As with employment changes, this would suggest that travel

planning (e.g. travel packs explaining available transport options in the local area) would be most effective before residents move into a new home.

Land use planning: The findings also suggest that land use planning has an important mediating role to play in enabling commuting by non-car modes when people move home or change employer. The regression models indicated that shortening journey times by public transport to employment sites encourages non-car commuting. This supports the case for investment in high quality public transport connections to employment centres in urban areas, including those in urban fringes. Mixed land uses were found to be associated with increased likelihood of initiating active commuting, suggesting that planning policies should prioritise mixed land use developments with short distances (less than 2 miles) between residential areas and employment opportunities.

7. CONCLUDING REMARKS

The results provide firm evidence that life events (in particular employment changes and residential relocations) are important determinants of commute mode changes. Life events must be considered in both conceptualisations of commute mode change and in transport policies concerned with promoting changes to commuting behaviour. Information was not available about transport interventions experienced by the survey participants and future research should seek to identify how life events interact with transport interventions to influence commuting behaviour.

The study also confirms longitudinally, that spatial context is an important determinant of how commuting behaviours change *over time* and that spatial planning (land use patterns and the structure of the transport network) has a role to play in influencing how people negotiate the journey to work over the course of their careers.

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