Department for Transport

Car Travel Econometrics

Moving Britain Ahead

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Executive summary

Background

1 England has seen significant growth in traffic over the last 60 years. However, over recent decades, growth in traffic has been slowing. The Department for Transport (DfT) is committed to understanding recent trends in traffic growth. In 2015, we published Understanding the Drivers of Road Travel (UDRT)[1] which highlighted how trends differed by population segments. UDRT enhanced understanding of the factors which affect the decision to drive, but there was little attempt to quantify them.

2 More recently the 'Provision of Travel Trends Analysis and Forecast Model Research'[2] (Travel Trends Analysis) was commissioned by DfT. This explored recent trends in trip rates and is used to inform forecasts in the National Trip End Model. Trips were disaggregated by individual characteristics, household characteristics and geographical / spatial factors.

3 Travel Trends Analysis showed that trips are affected by age, area type, income and other factors. However, the focus on trips means the study could not generalise to say how other factors, such as licence holding, affect car travel.

4 The National Travel Survey (NTS) has also shown a decline in car use among the young, who are less likely to hold driving licences or travel as far as previous generations. To investigate this DfT commissioned research into the factors driving young people's travel[3]. This considered how changes in young people's social and economic conditions, lifestyles and attitudes have affected their travel behaviour. Further work then assessed how these drivers and other anticipated changes could impact on future travel demand.

5 Relatively little work has attempted to quantify the effects of different factors on the decision to hold a driving licence, the probability of having access to a car or miles driven. There is also little analysis that controls for a wide range of demographic and socio-economic factors within the same framework. The purpose of this report is to measure these impacts.

Summary of methodology

6 The analysis was carried out over three stages using data from the National Travel Survey. It considered the relationship between socioeconomic and demographic variables and decisions about licence holding, whether to own or share a car, and how far to drive.

7 As well as analysis using the whole dataset, the sample was also split by region, age group, and time period. Further work assessed how the effect of age varied

[1] Department for Transport; DfT (2015) Understanding the drivers of road travel: current trends in and factors behind road use, January
[2] Atkins, AECOM and Imperial College London (2017), 'Provision of Travel Trends Analysis and Forecasting Model Research'
[3] Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). Young People's Travel – What's Changed and Why? Review and Analysis. Report to Department for Transport. UWE Bristol, UK. www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

according to area of residence.

8 The results of the regressions give the probability of a characteristic affecting the decision to hold a driving licence and own/share a car, and the extent to which mileage is affected. The impacts are measured relative to a specified base case. This provides a reference point to compare how the three measures of driving vary across the population. For example, in the case of licence holding the analysis suggests that those aged 17-29 are 30% less likely to hold a driving licence relative to the base case (those aged 65+).

9 The characteristics of the base case are an unemployed male, aged 65+, living alone in a rural area, further than 13 minutes from a frequent train or bus service, and a background in an unskilled occupation.

Summary of results

10 Across all three stages of the analysis, year of birth effects are important. Being born more recently is associated with a lower probability of licence holding and car access, and lower overall mileage. These effects are greatest for licence holding.

11 London also exhibits different travel trends relative to the rest of the country. This is shown both through the primary regressions, where living in London is itself an explanatory variable, and the regression splits by region.

Licence holding

12 The results for location type show that living in more urbanised areas is associated with a lower probability of licence holding. Living in London or a metropolitan area is associated with the lowest probabilities of licence holding relative to living in a rural area. Transport for London's 'Drivers of Demand for Travel in London' report[4] highlighted that London has a unique set of characteristics, including high levels of inward migration and the quality of its public transport provision, which may result in lower rates of licence holding. This could result in differences in travel behaviour, even compared to other conurbations.

13 Occupation type also has a significant impact on licence holding. Relative to unskilled workers, professional workers are most likely to hold a driving licence, while manual workers are least likely. The costs associated with using a car, such as insurance and running costs, may also vary across occupation types. These were found to be a deterrent to driving in Young People's Travel.

14 The results also highlight that there is a non-linear relationship between income and the probability of licence holding. Incremental increases in income for poorer individuals are associated with a higher probability of licence holding, whereas at higher levels of income further increases reduce the probability of licence holding. Individuals who earn more are likely to have a wider choice of other transport modes available to them, meaning they can substitute travel by car for other methods.

Car access

15 The number of adults in a household is the most important factor determining car access. Relative to those living in a single adult household, living in a household with two or more adults is associated with a seven-fold increase in the probability of having access to a car.

16 Living with children is associated with a higher probability of car access, relative to

[4] TfL (2014), Drivers of Demand for Travel in London: A review of trends in travel demand and their causes, http://content.tfl.gov.uk/drivers-of-demand-for-travel-in-london.pdf

living in a household without children. This may reflect households with children having a greater need to drive, for example when taking their children to school. Other research[5] has highlighted the importance of life stage on car ownership, where people who start families tend to move to suburban areas where public transport is not widely available. This analysis has attempted to control for some of these effects in the regressions.

17 The results continue to show that living in a more urban area is associated with a lower probability of car access, conditional on holding a driving licence. Research by TfL[6] suggests that changing attitudes to car ownership may have contributed to lower car ownership in London in particular.

Mileage results

18 Consistent with the rest of the analysis, living in London or a metropolitan area is associated with lower levels of mileage.

19 The results indicate females have lower mileage relative to male drivers. This is consistent with existing trends in the NTS that show females drive less than males. While there has been an increase in female mileage since the 1990s, this result may reflect that female labour market participation is lower than males. Consequently, their need to drive may be lower.

20 Corresponding with evidence shown in other reports[7], being a student is associated with higher mileage relative to the unemployed, conditional on having access to a car and licence holding. While this may contradict expectations about a student lifestyle, our analysis separates the effects of other factors such as age, which are correlated with being a student.

Regional results

21 The regional results show how the impacts of socioeconomic and demographic factors vary according to an individual's region of residence. Specifically, they provide results for the North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East and the South West.

22 The results highlight that changes in household composition and employment status are associated with smaller changes in the probability of licence holding and owning / sharing a car in London compared to other regions. However, living in a household with children leads to a significantly higher probability of owning or sharing a car in the capital, relative to those without. These effects illustrate that socioeconomic and demographic factors may have different impacts in London compared to other areas.

Age results

23 This section explores how the relationship between socioeconomic and demographic factors and the three stages of driving changes across different age groups. The age breakdown results split the sample into ages 17-29, 30-49, 50-64 and 65+.

24 The results highlight that the relationship between the decision to hold a driving licence, to own or share a car, and how far to drive, vary significantly across age

[5] Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). Young People's Travel – What's Changed and Why? Review and Analysis. Report to Department for Transport. UWE Bristol, UK. www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

[6] TfL (2014), Drivers of Demand for Travel in London: A review of trends in travel demand and their causes, http://content.tfl.gov.uk/drivers-of-demand-for-travel-in-london.pdf

[7] Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). Young People's Travel – What's Changed and Why? Review and Analysis. Report to Department for Transport. UWE Bristol, UK. www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

categories. Most notably the relationship between gender and the probability of licence holding and mileage is much weaker for those aged 17-29 compared to the 65+ group. This indicates that differences in driving behaviour between genders may decrease over time. The Young People's Travel work that was commissioned by DfT also suggests this.

Results across different time periods

25 The time split results break the sample down into 1995-2000, 2001-2006 and 2007-12. This shows whether the impact of different factors have changed over time.

26 The correlation between income and the three stages of driving has diminished over time. This corresponds with other work[8] showing the relationship between income and driving has weakened.

27 Across the three stages of driving the impact of age has also decreased over time. This suggests there has been convergence in the driving behaviour of different age groups. The only exception to this is the 17-29 age group, where the impacts on licence holding and car access have become more negative over time.

Next steps

28 These results provide important evidence on trends affecting car travel, which may help to inform DfT's transport modelling and appraisal techniques.

29 They highlight that DfT's forecasting models could be improved if London was treated differently to other regions. Evaluation of recent Road Traffic Forecasts[9] suggest that the National Transport Model may over forecast traffic in London. Consideration could be given on how to improve the accuracy of DfT's modelling suite when forecasting road traffic in London, and the potential value of doing so.

30 The income results are important and suggest it is becoming less correlated with the three stages of driving. While income is not directly captured in our modelling suite, GDP is used as a proxy for it. Consideration needs to be given to how this relationship will evolve over time.

31 The occupation type results show that socio-economic group is important in determining travel behaviour. Recent work[10] showed that the time of day in which people commute, in addition to the composition of trips people undertake, vary significantly by occupation (SEG). Similarly, this work shows differential impacts across the three stages of driving for occupations. Changes in labour force composition need to be monitored and could be considered as DfT looks to develop its modelling and appraisal tools further.

32 Apart from income and public transport availability, the other explanatory variables reflect potential segments that could be used in DfT's modelling and appraisal. The value of introducing additional segmentation could be reviewed when the models are updated. However, when assessing this, both the magnitude of the observed impacts and the size of the population that they apply to should be examined, so that any changes do lead to a tangible improvement in forecasts.

33 Further work is required to understand what is causing the trends in travel behaviour that have been observed. The analysis only identifies the correlation between each

[8] Marsden, G. et al. (2018) All Change? The future of travel demand and the implications for policy and planning, First Report of the Commission on Travel Demand, ISBN: 978-1-899650-83-5
[9] DfT (2018), Road Traffic Forecasts 2018
[10] Le Vine, S., Polak, J. and Humphrey, A. (2017) Commuting trends in England 1988 – 2015, Department for Transport

explanatory variable and the factors affecting car travel. Identifying what explains these results is important in determining whether the impacts will persist in future.

34 There is also potential for scenario analysis to help reflect these impacts. This could capture different futures, such as if recent trends in licence holding persist, and show the effect on road traffic in DfT's approach to modelling and appraisal. This is consistent with the recommendation in Young People's Travel to develop forecasting approaches which account for cohort differences in travel behaviour.

1. Introduction

Background

1.1 England has seen significant growth in traffic over the last 60 years. However, over recent decades, growth in traffic has been slowing. This is reflected in Figure 1, which shows the quantity of miles driven by cars and taxis remained largely flat between 2002 and 2014.

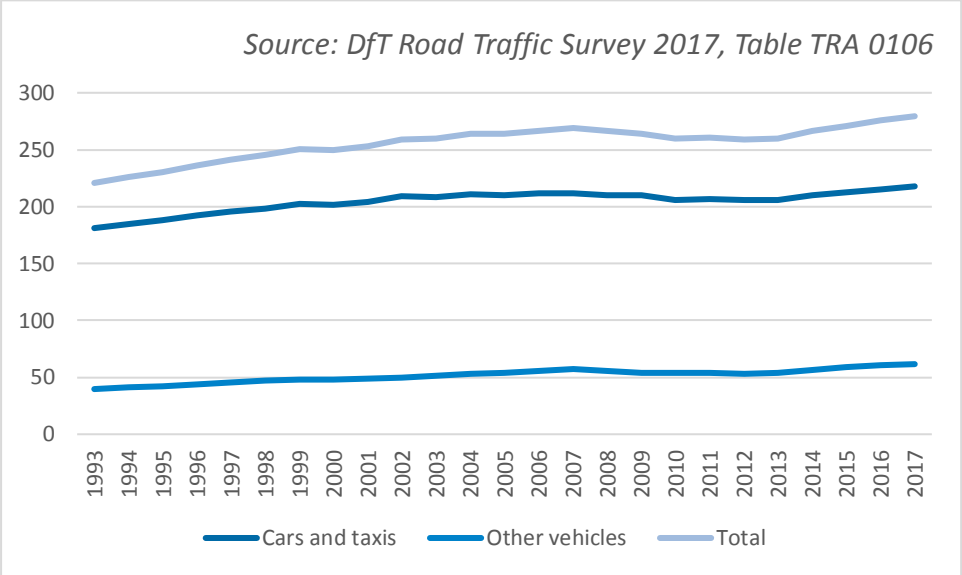

Figure 1 Road vehicle miles (billions) in England, 1993 to 2017

1.2 DfT is committed to understanding recent trends in traffic growth. In 2015, we published Understanding the Drivers of Road Travel (UDRT) [11] which highlighted how trends differed by population segments. Driving has risen amongst older age groups, those living in rural areas and lower income groups, whereas the young, those in urban areas and higher income groups are driving less.

1.3 UDRT found supporting evidence for trends found elsewhere in the literature. For instance, both real incomes and employment rates had fallen amongst the young and risen for older age groups. This may explain some of the fall in individual mileage. However, few studies have attempted to quantify the impact of income on car access and use, and how this relationship has changed over time.

1.4 More recently DfT commissioned 'Provision of Travel Trends Analysis and Forecast Model Research'[12] (Travel Trends Analysis) to inform the modelling approach in the National Trip End Model. This study undertook regression analysis to show the impact of different factors on trip types using NTS data between 2002 and 2012.

[11] Department for Transport; DfT (2015) Understanding the drivers of road travel: current trends in and factors behind road use, January
[12] Atkins, AECOM and Imperial College London (2017), 'Provision of Travel Trends Analysis and Forecasting Model Research'

1.5 Travel Trends Analysis highlighted that living in London was associated with lower trip rates, and that children also reduce the number of trips completed for most purposes. However, this study only investigated one component of travel by focusing on trip rates. It did not consider how licence holding, access to a car or total mileage are affected.

1.6 Additional work was commissioned to understand young people's travel trends. This culminated in the publication of 'Young People's Travel – What's Changed and Why? Review and Analysis'[13] (YPT) in January 2018. This sought to understand how social and economic conditions, lifestyles and attitudes have affected travel behaviour.

1.7 YPT found that the causes of changes in young people's travel behaviour lie largely outside of transport. Changes in young people's socio-economic conditions (for example lower disposable income and increased higher education participation) have helped drive changes in travel behaviour. However, the report states that the existing evidence base means that it is not possible to quantify the impact of these factors.

1.8 Evidence in YPT also suggests that the high costs associated with driving deter young adults, while growth in public transport has facilitated less car usage.

Aims and objectives

1.9 This work will quantify the relative importance of different factors on car travel demand using econometric analysis. Specifically, it considers the relationship between socioeconomic and demographic characteristics and the decision to hold a driving licence, to own or share a car, and how far to drive.

1.10 This report has two main aims:

- To inform DfT's modelling and appraisal. The findings can shed light on additional factors that could be considered, and highlight whether any underlying relationships have changed.
- To contribute to the evidence base on travel demand by quantifying the relative importance of different factors that determine demand for car travel. Relatively few studies have assessed the impact of different socioeconomic and demographic factors within the same regression framework.

1.11 The paper is structured as follows. Section 2 explains the methodology used in the report. Section 3 presents the findings from the analysis using the main regressions, while Sections 4 and 5 show the results split by region and age respectively. Section 6 explores whether there have been changes in the estimated impacts over time, whereas Section 7 considers if the impact of age varies across regions in the analysis. Section 8 concludes and sets out recommendations from the report. An annex is available showing the regression outputs for the whole sample results, the results with year of birth effects and regressions including age-area interactions.

[13] Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). Young People's Travel – What's Changed and Why? Review and Analysis. Report to Department for Transport. UWE Bristol, UK. www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

2. Methodology

2.1 This section outlines the methodology used in this analysis. The data used for the econometric analysis is introduced, followed by the model specification for the regressions. Subsequently the estimation procedure and the method for interpreting the results are presented. A worked through example is provided to help illustrate how the results should be understood.

Data used

2.2 This research uses the National Travel Survey (NTS), which is a household survey designed to monitor long-term trends in personal travel. Running since 1965, the survey collects information on how, why, when and where people travel. It also provides information on socio-economic and demographic characteristics, which forms the basis for this analysis.

2.3 Data collection consists of a face-to-face interview and a 7-day self-completed written travel diary, allowing travel patterns to be linked with individual characteristics. The analysis focuses on respondents from England only. In recent years, approximately 16,000 individuals in 7,000 households have participated in the NTS. Before 2002 the sample size was approximately a third of this size. However, when years are pooled there are reasonable samples for this analysis.

2.4 To understand demand for car travel at the individual level, we first examine the relevant aggregate statistics. Figures 2, 3 and 4 show the percentage of the population with a full driving licence, the percentage of households with access to a car, and distance travelled by private car. These statistics are used for constructing the three stages in the regression analysis.

2.5 Prior to 2002, the NTS sample was a third of what it is now; hence in the figures for before 2002 averages are taken over 3 years.

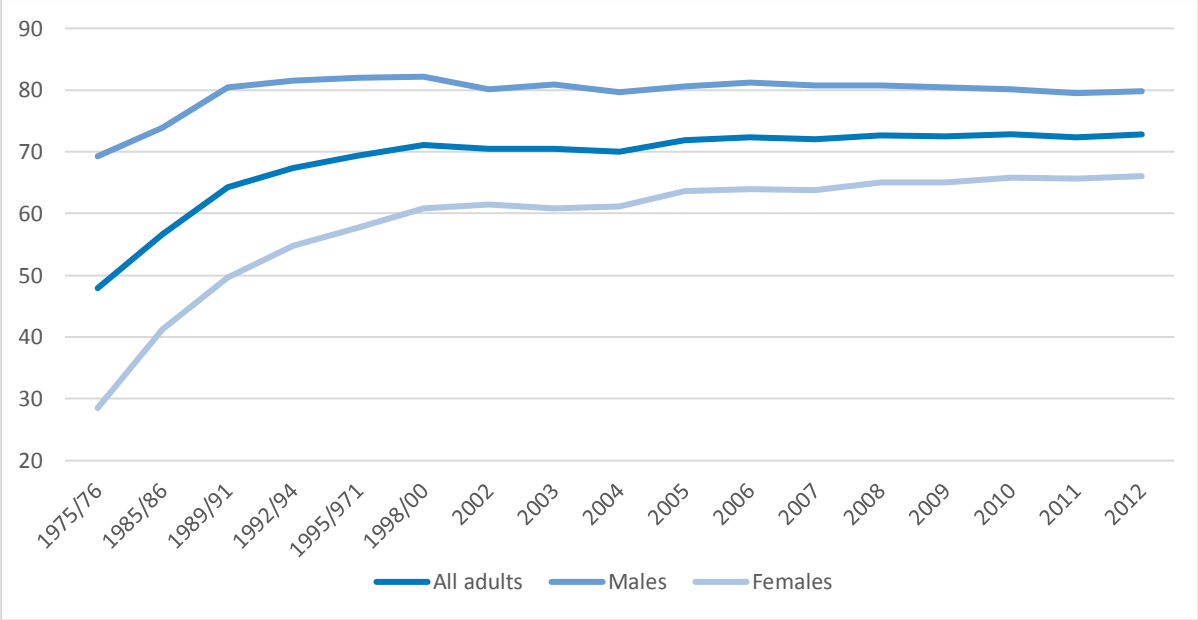

Figure 2 Percentage of population with full driving licence 1975/76 - 2012. Source: National Travel Survey

2.6 The percentage of licence holders increased between 1975/76 and the early 1990s. However, the pace of the increase has significantly slowed and since 2000 has largely plateaued. A greater percentage of men are licence holders than women, though the gap is steadily decreasing.

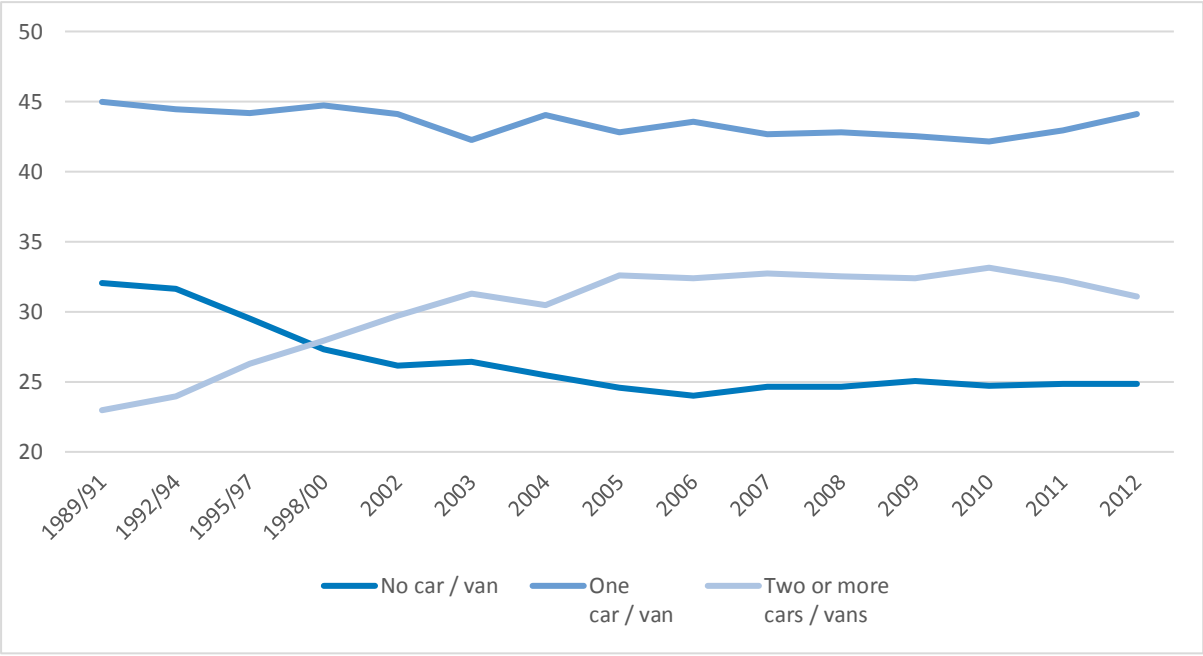

Figure 3 Percentage of households with car availability: England, 1989/91 to 2012. Source: National Travel Survey

2.7 The percentage of households without access to a car or van declined over the 1990s, and has stabilised since 2005. The increase in households with access to two or more cars/vans has approximately mirrored the decrease in households with no car/van. The number of households with one car/van has remained largely stable, within 40 to 45% of the population.

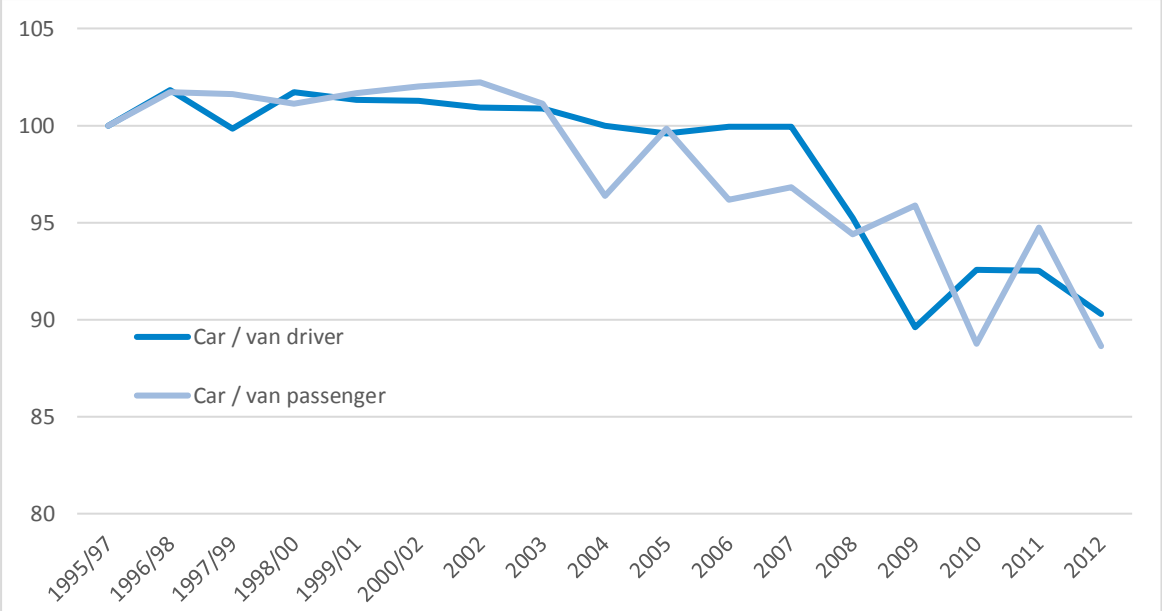

Figure 4 Average distance travelled by car/van driver or passenger – indexed (1995/7 = 100) England, 1995/97 to 2012. Source: National Travel Survey

2.8 Both car passenger and driver distance have declined since 2002. While there have been some upward spikes in specific years, there has been a clear drop in mileage since 2007. Car passenger distance is not included in this analysis.

Model specification

2.9 The decision about whether to drive can be broadly broken down into three stages: whether to obtain a full driving licence, whether to own or a share a drive (given an individual holds a driving licence); and how many miles to drive (given an individual has a driving licence and access to a car).

2.10 To understand the drivers behind these decisions, this analysis breaks the problem into three separate regression models. However, the sample size is progressively reduced for each stage of the analysis. The licence holding regressions use the entire sample, whereas the car access regressions are only performed on individuals who already have a driving licence. The mileage regressions are performed on individuals who have both a driving licence and access to a car.

2.11 Different combinations of variables were tested when deriving the regression specification. The final results show the variables that were found to be most significant in the primary regressions.

Primary regressions

2.12 This analysis uses binary logistic regression models to capture the first two stages of driving (obtaining a licence and having access to a car). A binary logistic regression is appropriate when the observed outcome is one of two possibilities.

2.13 The NTS records if an individual holds a driving licence. This forms the basis of the first stage of the analysis. The regressions show how socioeconomic and demographic characteristics affect the probability of licence holding, compared to a reference set of characteristics.

2.14 The logistic regression for licence holding was estimated on all individuals that were of driving age (aged 17 and over). This is estimated from an underlying latent variable model. Y^* is the unobserved, latent variable, which is given by

$$\mathrm{Y_i^*} = \alpha_0 + \alpha_1 \mathrm{age_i} + \alpha_2 \mathrm{gender_i} + \alpha_3 \mathrm{work_i} + \alpha_4 (\mathrm{income_i}) + \alpha_5\, \mathrm{area_i} + \alpha_6\, \mathrm{job\ type_i} + \alpha_7\, \mathrm{bus_i} + \alpha_8\, \mathrm{train_i} + \alpha_9 \mathrm{adults_i} + \alpha_{10} \mathrm{kids_i} + \varepsilon_i$$

and

$$\mathrm{Y_i} = 1[\mathrm{Y_i^*} > 0]$$

Where:

Variable type	Definition
i	individuals
income	continuous real individual income in tens of thousands GBP, adjusted using CPI to reflect 2014 prices
age	dummy variables for age band (17-29, 30-49 and 50-64); base case is 65+
gender	dummy variable for being female; base case is male
work	dummy variables for employment status of individual (full-time, part-time, student); base case is unemployed
area	dummy variables for location (small urban, large urban, metropolitan, London); base case is rural
job type	dummy variables for type of occupation (employer, professional, managerial, manual, non-manual); base case is unskilled, capturing occupations that do not easily fit into the other categories[14]
bus	dummy variable for living within a 13-minute walk of a frequent bus service; base case is no local frequent bus service within 13-minute walking distance
train	dummy variable for living within a 13-minute walk of a quarterly train service; base case is no local quarterly train service within 13-minute walking distance
kids	dummy variable for if children are present in the household; base case is no children present
adults	dummy variables for the number of adults living in the individual's residence (2 adults, 3+ adults); base case is one adult

And $\alpha_1, \alpha_2, \alpha_3$ etc are the model coefficients that were estimated.

2.15 Here $\mathrm{Y_i}$ is an indicator function which equals 1 if $[\mathrm{Y^*} > 0]$, and is zero otherwise. $\mathrm{Y_i^*}$ itself is related to the demographic and socioeconomic variables in the equation above, and an error term that is independently and identically distributed.

2.16 The probability of licence holding is given by a logistic transformation of this latent quantity Y_i:

$$\mathrm{P(licence\ holding} = 1) = \mathrm{f(Y_i)} = \frac{\exp^{\mathrm{Y_i}}}{1 + \exp^{\mathrm{Y_i}}}$$

[14] The occupation type variable is constructed using the Socio-Economic Group information from the National Transport Survey, where there are 19 categories of occupation'. The unskilled category is constructed using individuals who are classified as Personal Service, Own account non-professional, Farmer employee / manager, Farmer (own account), Agricultural worker or Armed forces.

2.17 The NTS also records if individuals have access to a car in their household. This is used as the basis for the second stage in our regression framework.

2.18 A latent quantity Z is calculated as a linear function of the explanatory variables for all the individuals who have a licence, and the probability of car access is given as:

$$\mathrm{P}(\text{car access} = 1 | \text{licence holding} = 1) = \mathrm{f}(\mathrm{Z_i}) = \frac{\exp^{\mathrm{Z_i}}}{1 + \exp^{\mathrm{Z_i}}}$$

2.19 The mileage regressions are estimated using a Least Squares estimator. Because the variance in mileage is not constant across individuals, heteroscedastic-consistent errors are used to ensure that the estimated coefficients are efficient and that statistical tests of significance are valid. When looking at the impacts on mileage, the sample is further restricted to only those with a driving licence and access to a car:

$$(\mathrm{Miles_i} | \text{car access} = 1) = \alpha_0 + \alpha_1 \mathrm{age_i} + \alpha_2 \mathrm{gender_i} + \alpha_3 \mathrm{work_i} + \alpha_4 (\mathrm{income_i}) \ldots$$

2.20 In each regression, the results are relative to a base case, specified in 2.14 as an unemployed male, aged 65+, living alone in a rural area, further than 13 minutes from a frequent train or bus service, and a background in an unskilled occupation.

2.21 A base case is necessary because dummy variables quantify the relative impact of a specific trait or characteristic. Without a reference point we would be unable to determine how the probability of licence holding, car access or total miles driven varied according to socioeconomic and demographic characteristics. More detail of why specific characteristics were chosen for the base case is provided in Section 3.

2.22 The summary statistics for the base case are as follows:

	Percentage of licence holders	**Percentage of people who have access to a car**	**Mileage per person**
Rural	12.8%	13.7%	162.4
Age 65+	15.8%	16.2%	81.1
Unemployed	27.6%	27.4%	82.0
Unskilled	13.4%	13.0%	113.7
One adult household	14.2%	12.9%	133.9
No children in household	69.2%	68.3%	125.7
Does not live within 13-minutes' walk of frequent bus service	65.1%	67.3%	139.7
Does not live within 13-minutes' walk of frequent train service	84.3%	85.4%	133.0
Male	54.4%	53.7%	160.1

Figure 5 Base case statistics for licence holding, car access, and mileage

2.23 The regressions are weighted using weights in the NTS to account for non-response. These are calibrated by age, gender and region. The interview sample weights are used for the car access and licence holding regressions, since this information is given in the NTS interview. The diary sample weights are used for the mileage regression because individual mileage is recorded in the NTS diary.

Extensions

2.24 Several extensions have been applied to the primary regression. Firstly, year of birth dummy variables and survey year dummies have been tested. Year of birth dummies are used to test the hypothesis that there is variation in travel behaviour for individuals in different year ranges. For example, they assess whether an individual born in the early 1990s behaves differently to one born in the early 1960s. Survey year dummies are used to test if there are year specific effects that are not captured by the other independent variables.

2.25 The year of birth and survey year dummies were tested in the following models:

$$\mathrm{P(licence\ holding)} = \mathrm{f}(\mathrm{Y} + \delta_{\text{early 60s}}\mathrm{born}_{\text{early 60s}} + \delta_{\text{late 60s}}\mathrm{born}_{\text{late 60s}} + \cdots + \delta_{\text{late 90s}}\mathrm{born}_{\text{late 90s}} + \delta_{1995}\mathrm{year}_{1995} + \cdots + \delta_{2010}\mathrm{year}_{2010} + \delta_{2011}\mathrm{year}_{2011})$$

$$\mathrm{P(car\ access|licence\ holding} = 1) = \mathrm{f}(\mathrm{Y} + \gamma_{\text{early 60s}}\mathrm{born}_{\text{early 60s}} + \gamma_{\text{late 60s}}\mathrm{born}_{\text{late 60s}} + \cdots + \gamma_{\text{late 90s}}\mathrm{born}_{\text{late 90s}} + \gamma_{1995}\mathrm{year}_{1995} + \cdots + \gamma_{2010}\mathrm{year}_{2010} + \gamma_{2011}\mathrm{year}_{2011})$$

$$(\mathrm{Miles_{it}|car\ access} = 1) = \mathrm{Y} + \rho_{\text{early 60s}}\mathrm{born}_{\text{early 60s}} + \rho_{\text{late 60s}}\mathrm{born}_{\text{late 60s}} + \cdots + \rho_{\text{late 90s}}\mathrm{born}_{\text{late 90s}} + \rho_{1995}\mathrm{year}_{1995} + \cdots + \rho_{2010}\mathrm{year}_{2010} + \rho_{2011}\mathrm{year}_{2011}$$

2.26 Where:

Born = the year range in which the individual was born, including 1955-1959, 1960-64, 1965-69, 1970-74, 1975-9, 1980-4, 1985-9, 1990-94, 1995-99. The base case is being born in 1954 or earlier

Year = the survey year, ranging from 1995 – 2011. The base case is 2012

2.27 Interactions terms were also tested for age and location, as shown in the following specification:

$$\mathrm{P(licence\ holding)} = \mathrm{f}(\mathrm{Y} + \mathrm{age_i area_i})$$

$$\mathrm{P(car\ access|licence\ holding} = 1) = \mathrm{f}(\mathrm{Y} + \mathrm{age_i area_i})$$

$$\mathrm{P(mileage|car\ access} = 1) = \mathrm{f}(\mathrm{Y} + \mathrm{age_i area_i})$$

2.28 Interaction terms show whether the impact of being a certain age is different across regions. These results also help determine whether heteroscedasticity is an issue in the binary logistic regressions. Interaction terms can help reduce any unequal variance across the sample and result in more efficient estimators.

Methodology for interpreting the results

2.29 The results generated from the regression analysis assume that all other explanatory variables are controlled for. For example, when considering the effect of being a student (relative to being unemployed) on the probability of licence holding, all other factors in the regression are held constant. This means the regressions can isolate a specific relationship.

2.30 To interpret the logistic regression results, the estimated effects are transformed to generate the estimated probabilities. These are the relative probability of either holding a licence or having access to a car in comparison to a defined base case.

2.31 As an example, the relative probability of an individual aged 30-49 holding a driving licence was estimated to be 88%. This should be interpreted as those aged 30-49 being 88% more likely to hold a licence, all else being equal, relative to an individual aged 65+ (the base case).

2.32 To show the percentage impact that different factors have in the mileage regression relative to the base case, each of the estimated coefficients is divided by the constant in the regression.

2.33 We would advise caution against multiplying the estimated coefficients across the regressions. The samples get progressively smaller between the licence holding, car access and mileage regressions. This means the estimated relationships may partly reflect differences in unobserved characteristics across the samples. Each of the estimates will also have uncertainty associated with them. This means any percentages derived using this approach will themselves have a margin of error.

2.34 A worked through example for interpreting the results is shown in Box 1.

Box 1 - guide to interpreting the results – a worked through example for the effect of being a student

This guide helps explain how to interpret the regression results, taking the employment category 'student' as an example. The % effects need to be interpreted relative to individuals who are unemployed.

The licence holding results show that relative to the unemployed, students are 97% more likely to hold a driving licence, holding other factors constant. This means that other factors in the regression, such as income, location, age, occupation type, household composition, the number of children in a household and occupation type are all controlled for.

The car access results show that relative to an unemployed individual who holds a driving licence, a student is 22% less likely to own or share a car. This also holds all other factors constant and is conditional on students holding a driving licence. People who do not own a driving licence are removed from the sample.

The mileage results show the average percentage difference associated with a specific characteristic on mileage, holding other factors constant. These suggest that relative to the unemployed, students drive 27% further, conditional on owning or sharing a car and holding a driving licence.

Some caution is required in interpreting these results. For example the licence holding regressions do not show the raw percentage difference between licence holding rates for students and unemployed individuals in the NTS, because they control for other factors. This means they attempt to isolate the specific correlation between a characteristic and the probability of licence holding when other socioeconomic and demographic characteristics are held constant. They do not mean that in practice students are 97% more likely to hold a driving licence than unemployed individuals.

These results also do not imply causality. This means that being a student does not increase the probability of holding a driving licence by 97%. There may be other factors, such as parental income, which are not controlled for in the analysis which increase the likelihood of both licence holding and being a student. Other factors may also be influential but cannot be modelled within this regression framework, since there is no individual level data on them. For example motoring costs may affect the decision to drive because they make car usage less affordable. Due to data limitations these are not captured in the analysis, meaning the framework could suffer from omitted variable bias.

2.35 Regional results are interpreted in the same way, but for each individual region. For example, if the impact of being aged 30-49 upon mileage in London is 31%, this means the mileage of those aged 30-49 who live in London is on average 31% greater than the base case (individuals aged 65+) who also live in London. Similarly, the base group for the effect of location in the age regressions would be individuals aged 65+ who live in rural areas.

2.36 All the factors tested are modelled as dummy variables, except income which is a continuous variable. The dummy variables show the percentage difference in the probability of licence holding or car access relative to the base case. In the mileage regression they each show the percentage difference in total miles recorded in the NTS relative to the base case.

2.37 By contrast the income variables show the impact that an incremental change in income has on the outcome. The marginal effect of income on licence holding, car access or mileage will vary based on the initial income level because it is included in the regressions as a linear and square term. Consequently, the magnitude of the income variables are not directly comparable to other variables in the analysis.

Estimation procedure

2.38 In addition to the regression results for the whole sample, a series of disaggregated results have been produced. These provide a breakdown for different regions and age groups, to show how the impact of explanatory variables change across the population.

2.39 It is also possible that the impact of certain factors has changed over time. To test this the sample was broken down by time period. This assesses how the magnitude of factors change for the 1995-2000, 2001-6 and 2007-12 sample years.

3. Factors affecting car travel demand

3.1 This section presents the regression results for the whole sample. The ten factors that will be discussed are:

- Location - split into small urban, large urban, metropolitan and London. The base case is rural
- Age - split into 17-29, 30-49, and 50-64. The base case is 65 or over
- Income - a continuous variable modelled using a linear and square term. The coefficients can be used to derive the predicted probability of licence holding or car access at a given level of income, or the average mileage of an individual with a given level of income, holding other factors constant
- Employment status - split into full-time, part-time and student. The base case is unemployed
- Occupation type - split into manual, non-manual, professional, manager, and employer. The base case is unskilled. The unskilled category is constructed using individuals who are classified as Personal Service, Own account non-professional, Farmer employee / manager, Farmer (own account), Agricultural worker or Armed forces
- Access to a frequent train - shows whether an individual lives within 13 minutes of a frequent land surface train station. The base case is not living within 13 minutes of a frequent land surface train station
- Access to a frequent bus - shows whether an individual lives within 13 minutes of a frequent bus service. The base case is not living within 13 minutes of a frequent bus service
- Number of adults in a household - split into two adult households and three or more adult households. The base case is a single adult household
- Number of children - a variable capturing whether there are children in a household. The base case is not having children in a household
- Gender - split into male and female. The base case is male

3.2 A key theme across the regressions is the impact of household composition. Living in a household with either two adults or more than two adults increases the probability of both licence holding and having access to a car. The estimated probabilities in the car access regressions for the household variables are among the largest in the entire analysis. However, the impacts on overall miles driven are smaller.

3.3 There is a clear pattern evident in the location results. The probability of holding a driving licence, the probability of owning or sharing a car, and total mileage, are all lower in more urbanised areas. The most negative impacts are found in London.

3.4 The report shows that relative to being unemployed, being in full-time or part-time work is associated with a higher probability of licence holding, car access, and higher

mileage. The effects on car access are particularly large. However, being a student leads to the highest probability of licence holding. This may be because other characteristics associated with lower car travel, such as age, have been controlled for in the analysis.

3.5 Age is also important. The results highlight the trend identified elsewhere that younger individuals are less likely to hold driving licences or have access to a car relative to other age groups. However conditional on having access to a car and a licence, those aged 17-29 drive further than those aged 65+. This indicates that those aged 17-29 who hold a driving licence and own/share a car have similar driving patterns to individuals aged 30-49 and 50-64.

Location

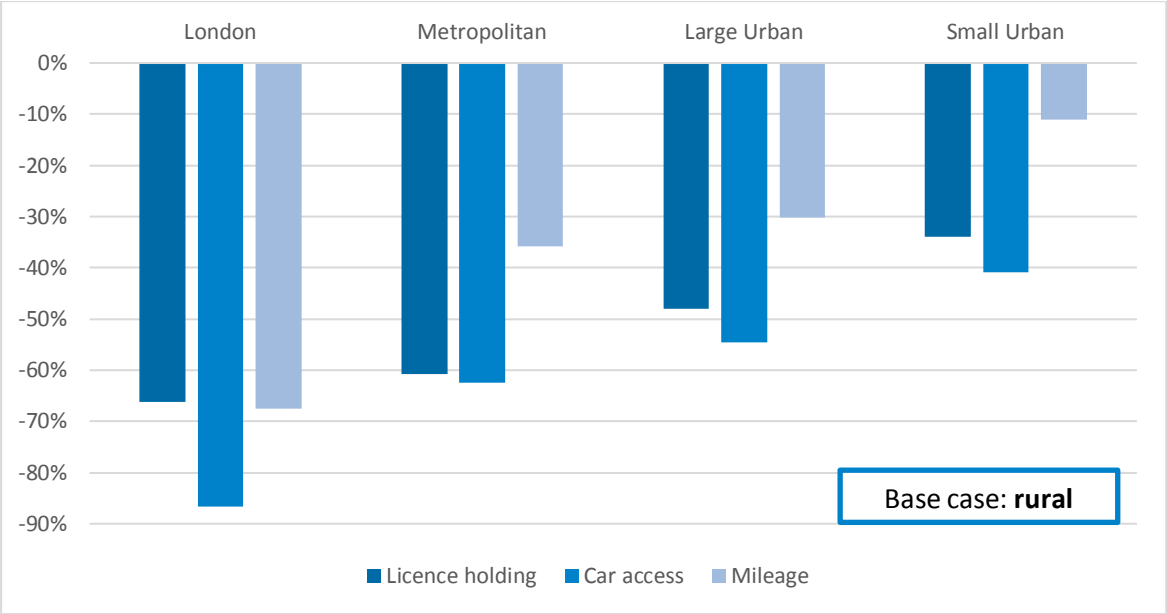

Figure 6 Relationships between location type and licence holding, car access and mileage

3.6 The location variables reflect the degree of urbanisation in the area that somebody lives. They distinguish between London, Metropolitan areas, large urban areas (where more than 25,000 people live), small urban areas (where 3-25,000 people live) and rural areas (where less than 3,000 people live).

3.7 London is considered separately from other urban areas because NTS data has shown it has lower attachment to car travel relative to other regions. It has a lower proportion of licence holders, more households that do not own a car / van, and the average distance travelled by car / van is lower than other areas. These proportions are low even relative to other urban conurbations recorded in the NTS.

3.8 The location results must be interpreted relative to individuals living in a rural area. This was selected as the base case because these areas are expected to be most dependent on cars. There are fewer alternative modes of transport in rural regions, providing a useful benchmark to see how licence holding, car access and mileage change as areas become more urbanised.

3.9 The primary regression results show there is a negative association between how urbanised an area is and the three driving indicators, holding other factors constant.

This is most true for car access. In all cases, the impact of living in London has the strongest downward association.

3.10 These findings are consistent with Transport for London's 'Drivers of Demand for Travel in London' report[15]. London has unique characteristics, including high inward migration and the quality of its public transport, which are different to other area types and may result in lower licence holding, car access and individual mileage.

3.11 Some caution is required in interpreting these percentages. The results for car ownership do not imply that car ownership is 87% lower than the rest of the country. Instead they indicate that when other factors in the analysis are controlled for (such as age, income, occupation type etc), the probability of an individual living in London owning a car is 87% lower than for an individual living in a rural area.

Age

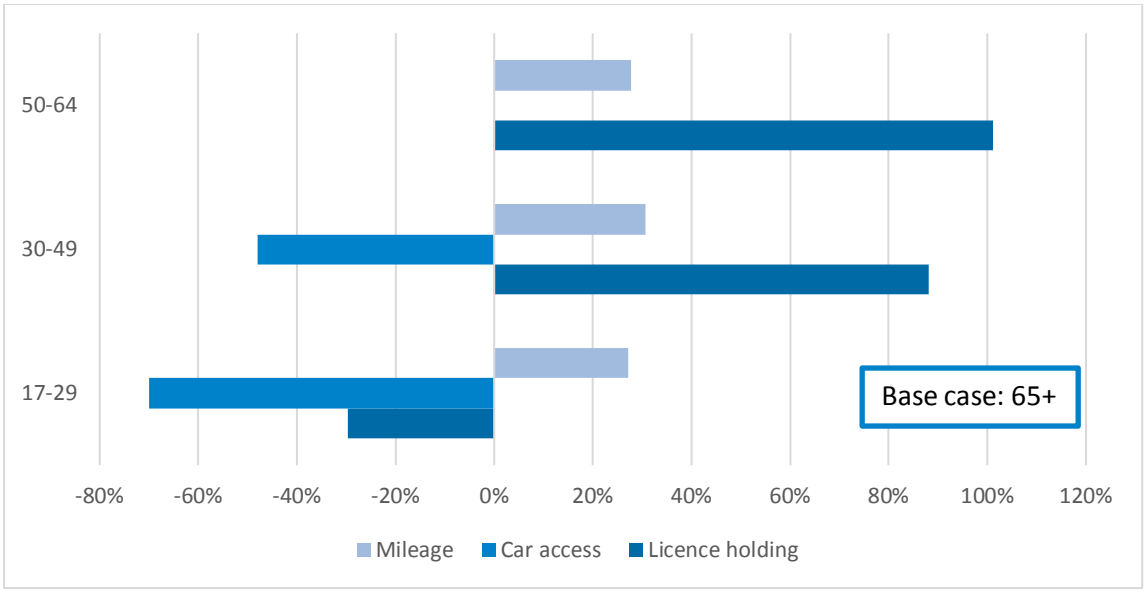

Figure 7 Relationships between age and licence holding, car access and mileage

3.12 Recent studies including URDT and YPT have shown that young people are less inclined to take up driving. The results in Figure 7 support this, where the impacts of being in a specific age band are given relative to being aged 65+. This was selected as the base case since it encompasses the oldest individuals in the analysis, which helps to highlight the differences in travel behaviour relative to progressively younger age brackets.

3.13 Belonging to the younger age range (17-29) decreases the likelihood of having a driving licence and access to a car, holding other factors constant. Being aged 30-49 or 50-64 increases the likelihood of licence holding, and decreases the likelihood of having access of to a car, holding other factors constant.

3.14 The change in the size and direction of the impact for licence holding between 17-29 and 30-49 could be indicative of a delay in major life events, such as marriage and having children.

[15] TfL (2014), Drivers of Demand for Travel in London: A review of trends in travel demand and their causes, http://content.tfl.gov.uk/drivers-of-demand-for-travel-in-london.pdf

3.15 The age variables also show that other age categories drive approximately 30% further than those aged 65+, holding other factors constant. This means that younger people who hold a driving licence, and own/share a car, are likely to drive a similar distance to other age ranges. This suggests the cause of the reported trend in younger people driving less may be due to the reduced likelihood that they have a driving licence or access to a car. Similarly, it indicates that although there has been growth in older people's mileage, they still drive less than other age groups.

Year of birth variables

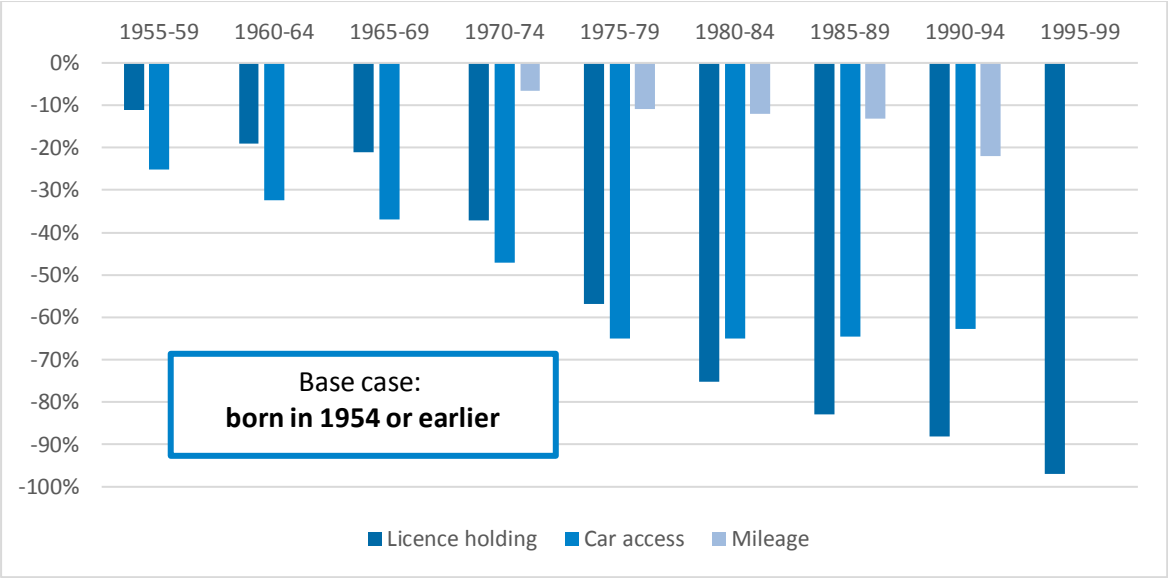

Figure 8 Relationships between year of birth variables and licence holding, car access and mileage

3.16 This section presents the regressions which included year of birth variables. These show how being born more recently affects licence holding, car access and mileage relative to being born in 1954 or earlier. Dummy variables for different survey years are also included in the regressions.

3.17 Year of birth variables are different from age variables since they capture the impact of being born in a given set of years. In this respect, a 17-29-year-old who was born in the late 80s might have different driving behaviour to a 17-29-year-old who was born in the early 90s.

3.18 This is an important avenue of inquiry. Young people have shown unanticipated driving behaviour in recent years. Understanding the relationship between year of birth and car travel will help us understand if recent trends can be attributed to being born at a given time, as opposed to being a particular age. This could help us clarify if young people will continue their current driving behaviour or if their behaviour will change as they grow older.

3.19 Figure 8 shows the relationships between being born in a particular year range and licence holding, car access and mileage. The results that are 0% are statistically insignificant. There is a clear negative association between belonging to a more recent year range on licence holding, car access, and mileage, though this is of a considerably smaller magnitude for mileage.

3.20 The results for licence holding show that individuals born more recently are less likely to hold a driving licence. This is also consistent with recent data in the NTS, which shows that over time licence holding rates have declined for individuals aged 17-

29[16]. However, it is uncertain whether younger generations will resume a more normal pattern of driving as they age or if these generational effects will persist.

3.21 These results are consistent with evidence in Young People's Travel. The study found that young people today are less likely to have access to a car or hold a driving licence compared to young people in the past. Changes in life circumstances, such as a greater reliance on low paid work and differences in values may account for these changes.

3.22 However, some caution is required in interpreting these results, since they may capture similar effects to the age variables. The impact that the year range variables have on the other explanatory variables is shown in Annex B.

Survey year variables

3.23 This section illustrates the effect of the survey year dummy variables. The survey year variables were added to a model that already included age and year of birth variables, and are intended to illustrate the impact of being surveyed in a given year. These effects should be interpreted relative to the impact of being surveyed in 2012.

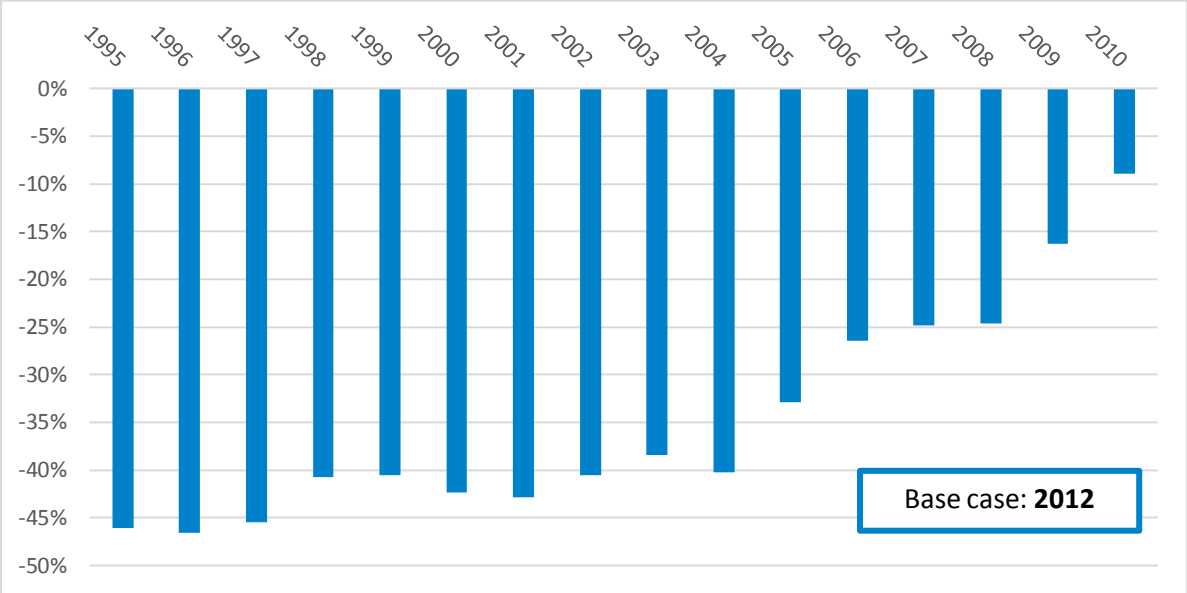

Figure 9 Relationship between survey year and the probability of licence holding

3.24 Most of the survey year dummies are statistically insignificant for car access, hence they are not shown. The only significant result is for 1995, which implies those surveyed in 1995 were 26% less likely to have access to a car relative to individuals interviewed in 2012, holding other factors constant. Given the relative stability of car availability shown in Figure 3 this result is perhaps unsurprising.

[16] DfT (2018), National Travel Survey, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729521/national-travel-survey-2017.pdf

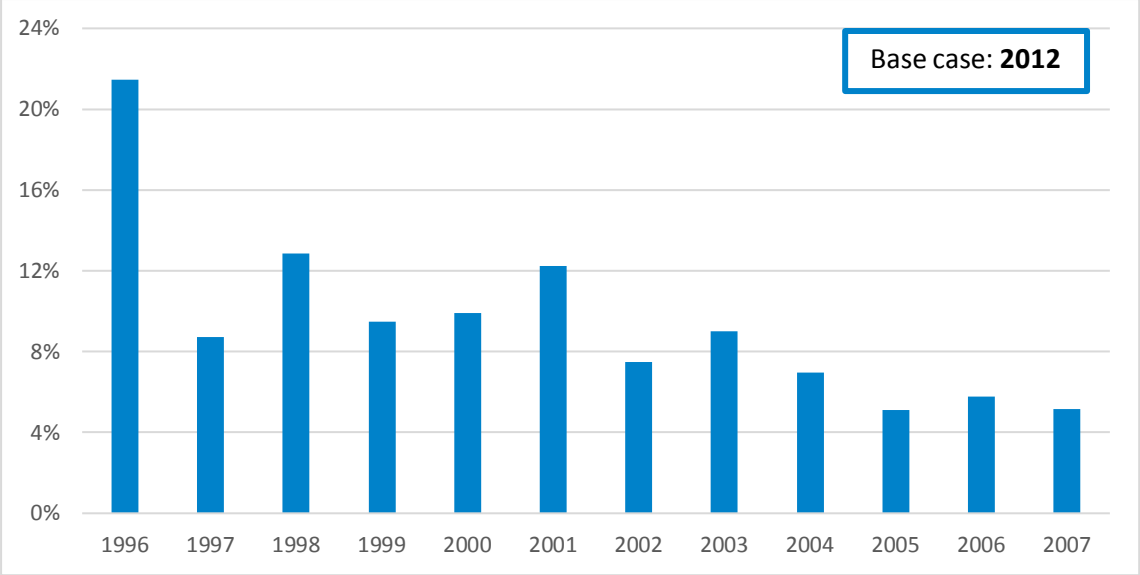

Figure 10 Relationship between survey year and mileage

3.25 Figure 10 shows the results for the measured impact of being surveyed in each year on mileage between 1995 and 2012. The coefficients are smaller than for licence holding, indicating that individual mileage is less susceptible to year effects. However, the impact is negative and insignificant between 2008 and 2010. This may reflect the negative impact of the 2008 recession.

3.26 This result indicates that prior to 2008 people's mileage was higher than can be solely explained by other explanatory variables in the primary regression analysis. This is consistent with Figure 4, which shows there was a sharp drop in average car driver miles after 2007.

Income

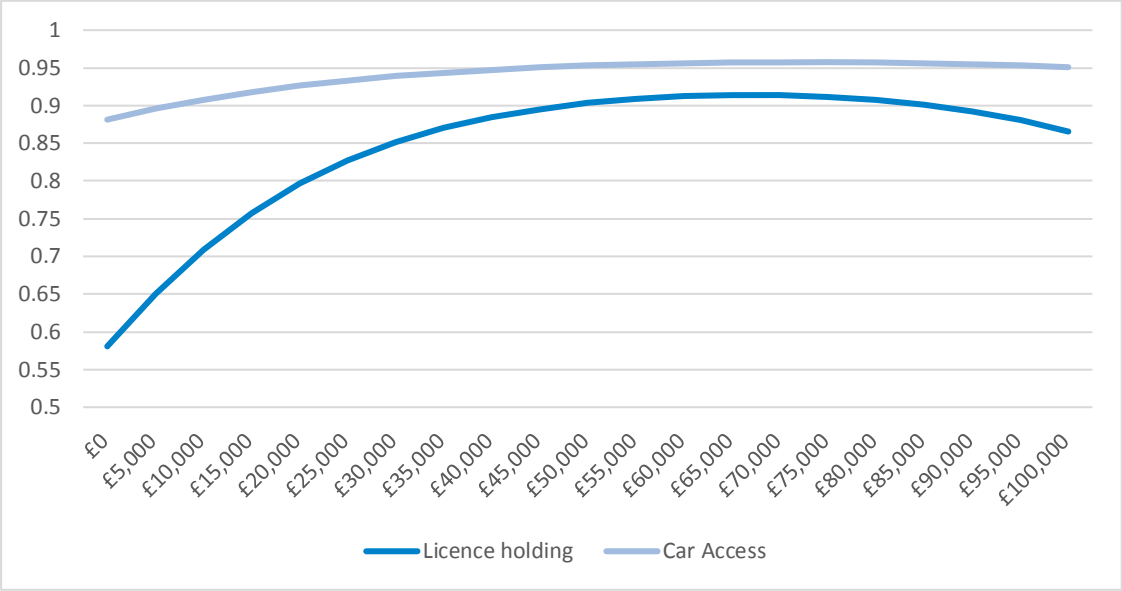

Figure 11 Predicted probabilities of licence holding and car access for the base case at different levels of income

3.27 Figure 11 shows how the predicted probabilities of licence holding and car access change as income changes, holding other factors constant. Income is recorded in nominal prices in the NTS, and in this analysis is adjusted to reflect 2014 prices using the Consumer Price Index. The results show that up to £66,796, marginal increases are associated with a higher probability of licence holding. However, after this point the predicted probabilities decrease. This may reflect how individuals with higher income are more able to afford other forms of travel, reducing their dependency on cars.

3.28 The relationship between income and the predicted probability of car access is more stable. While increases in income are associated with a higher probability of car access up to £72,504, the relationship is flatter compared to the relationship between income and licence holding.

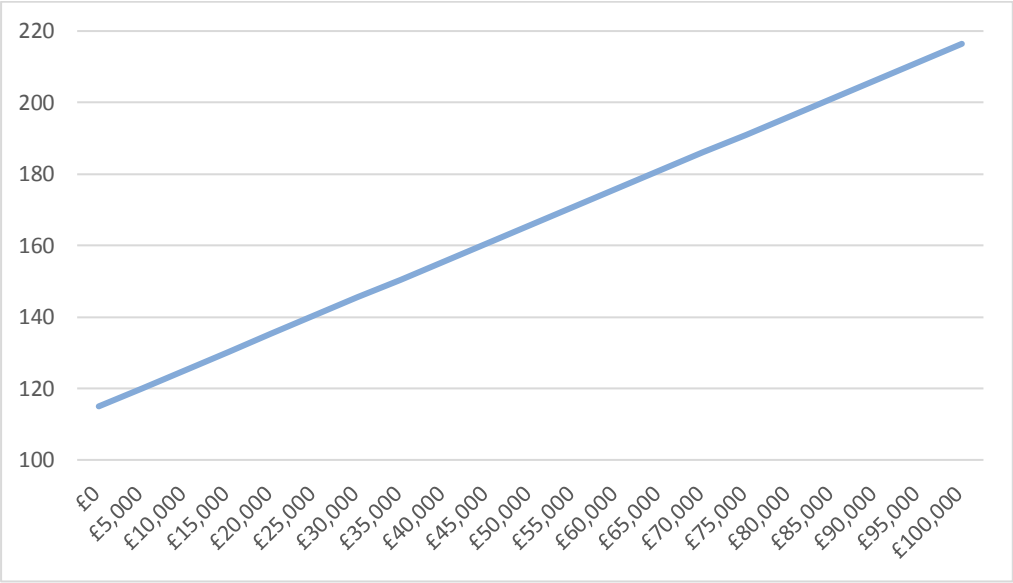

Figure 12 Estimated relationship between income and mileage

3.29 Figure 12 shows a positive association between income and mileage. However, the squared term is insignificant, implying that there is a linear relationship between miles driven and income. This suggests the nature of the relationship is different compared to licence holding and car access.

3.30 This work has reaffirmed that individual income is related to decisions relating to licence holding, car access and mileage. It also builds upon existing work by exploring whether the relationship is linear.

3.31 In section 6 the report explores whether this relationship has changed over time. This is particularly interesting given the observed weakening in the relationship between income and driving.

Employment status

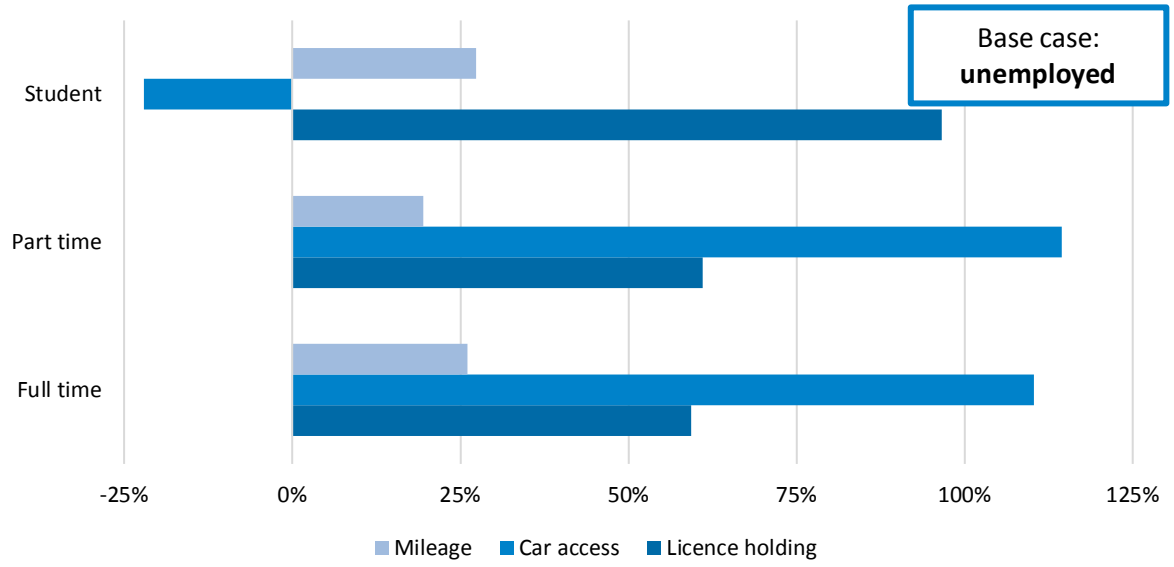

Figure 13 Relationships between employment type and licence holding, car access and mileage

3.32 Figure 13 shows the relationships between employment status and licence holding, car access and mileage. The employment variables show the associated impacts relative to unemployed individuals, holding other factors constant. This was selected as the base case since it provides the most useful benchmark for assessing how travel behaviour changes as people engage in education or employment.

3.33 Being a student is associated with a larger positive impact on the probability of licence holding relative to being in employment. This is an unexpected result given that a student lifestyle is typically associated with driving less. However, the results are consistent with similar analysis in YPT. This showed that relative to those that are not students / employed, students are more likely to hold driving licences. This result may reflect how other factors associated with a student lifestyle, including income and age, are controlled for in the analysis.

3.34 For car access, those in employment are significantly more likely to have access to a car than the base case. Being a student has a mild negative impact. These results may be indicative of the costs of driving.

3.35 Mileage is the least responsive and most consistent of the three stages once licence holding and car access have been considered. Being in employment or education is associated with a smaller increase in mileage, suggesting that the need to drive is somewhat consistent across employment categories.

3.36 However, caution is required in interpreting these results. Employment status may be capturing the effects of unobservable characteristics. People in specific employment brackets may have traits which are being captured by these variables. Similarly, employment status and other variables in the regression, such as location type, may be partially correlated with unobservable characteristics. This means the results do not imply that employment status causes people to drive further.

Occupation type

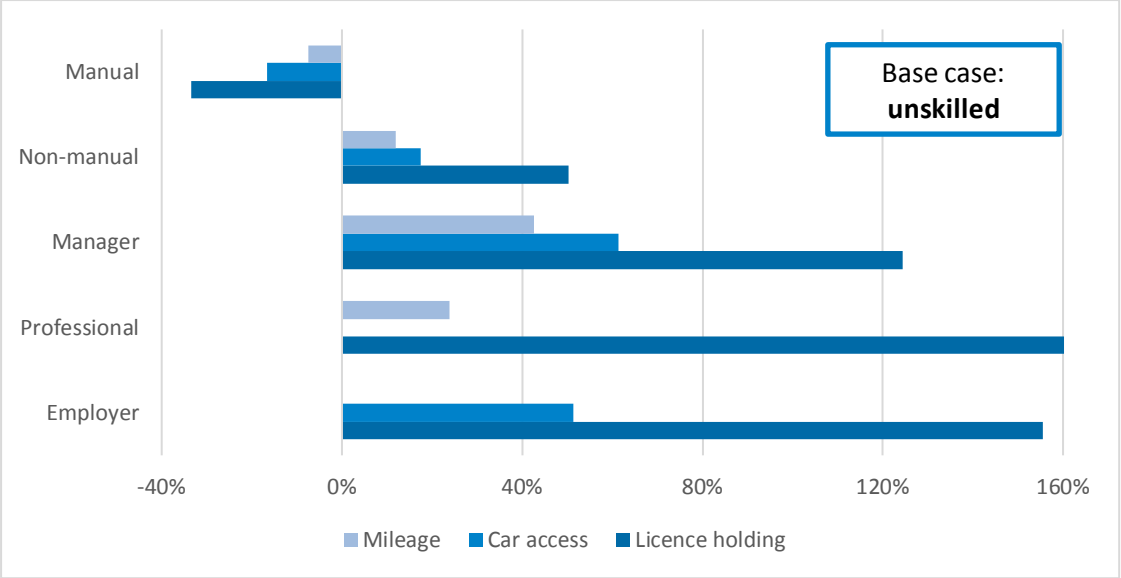

Figure 14 Relationships between occupation type and licence holding, car access and mileage

3.37 Figure 14 shows the relationship between occupation type and licence holding, car access and mileage relative to unskilled occupations, holding other factors constant. This is a broad category which captures occupations that do not easily fit into the other categories. It is derived using the National Statistics Socio-Economic Classifications data collected in the National Travel Survey, and is described further in 3.1. It was selected as the base case because it provides a useful benchmark for comparing the relative impacts for individuals working in other occupation types.

3.38 Being an employer, manager, professional or non-manual worker increases the likelihood of licence holding and car access relative to unskilled workers. Belonging to one of these occupation types is also associated with higher mileage, relative to being an unskilled worker. However, the size of this impact varies considerably per stage of driving. The probability of licence holding varies the most with respect to the base case. Mileage is again the least responsive out of the three stages.

3.39 These results broadly show that individuals in occupations that are generally associated with higher skill levels, such as managers, employers and professional occupations, have higher relative probabilities of holding a driving licence or car access. This may partly reflect the costs of insurance and car running costs, which vary across occupation type. YPT found that motoring costs were a deterrent to driving for young people.

3.40 However, caution is required in interpreting these results. The occupation categories are broad and will encompass a wide range of roles with different levels of skill and responsibility. For example, the ‘manual’ category includes the category ‘skilled manual’, ‘semiskilled manual’ and ‘unskilled manual’.

Public transport availability

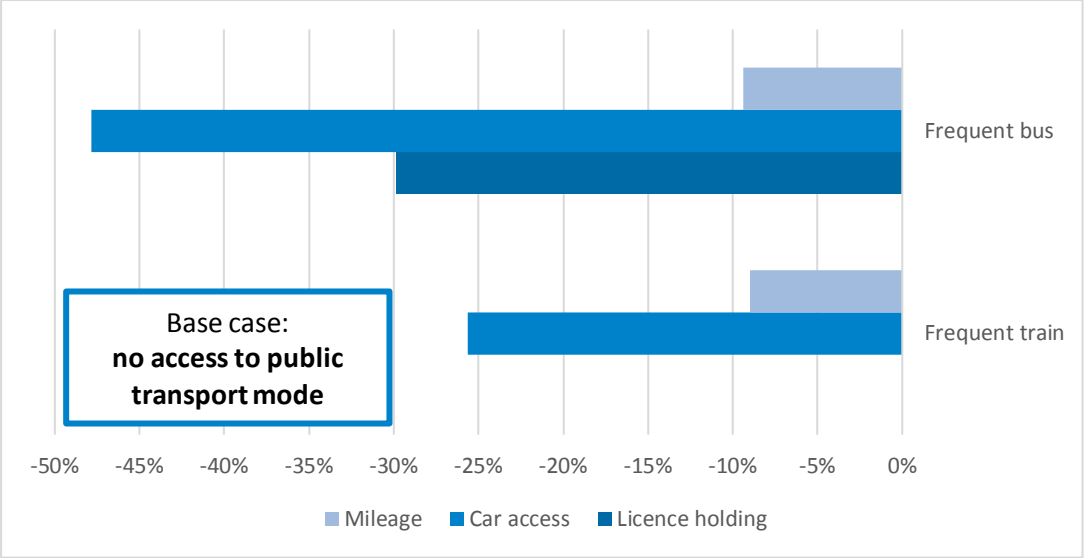

Figure 15 Relationships between public transport proximity and licence holding, car access and mileage

3.41 Living within a short distance of frequent local buses is associated with a lower probability of licence holding and car access, holding other factors constant. This is consistent with local buses acting as substitutes for cars. However, access to a local bus has less impact on mileage for those who already have a licence and access to a car.

3.42 Access to a train service is associated with no significant impact on licence holding. This suggests that living within walking distance of a train service does not deter people from learning to drive. However, there is a significant negative impact on car access. Conditional on holding a licence, people may perceive there as being less value in car ownership if they can travel by train more easily. There is also a small negative impact on mileage.

3.43 The substitution effect between cars and public transport appears strongest for buses. Travelling by bus is may be affordable for people compared to travelling by train, if they forego car usage.

3.44 A limitation of this analysis is that London Underground stations are not included in the definition of a train station. This means that the results may not accurately convey the impact of living near a frequent train service in London. Similarly, the NTS variables only capture whether someone lives within a 13-minute walk of a train or bus service. This may exclude individuals who live within easy driving distance of a station.

Household composition

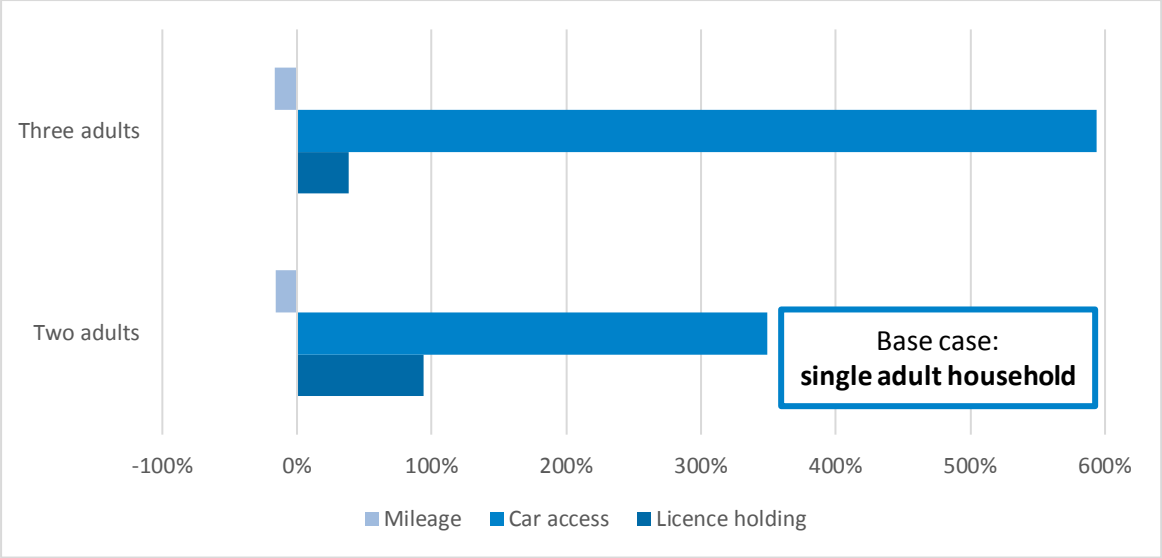

Figure 16 Relationships between household composition and licence holding, car access and mileage

3.45 Figure 16 shows the relationship between different household compositions and licence holding, car access and mileage relative to living in a single adult household. This is used as the base case because it provides a useful point of reference for considering how car travel indicators change as the number of adults in a household increases. These results assume that all other factors are held constant.

3.46 Belonging to a two-adult household or a household with more than two adults is associated with a higher probability of holding a licence. This is most true for individuals who belong to a two-adult household. However, it is unclear why two adult households are more affected than households containing more than two adults.

3.47 Larger households are also much more likely to have access to a car. The estimated effects are among the largest recorded in the primary regressions. This is especially true for those belonging to a household with more than two adults. The probability these individuals have access to a car is nearly seven-fold higher than the base case. This could reflect the breadth of the category 'living in a household with more than two adults'. If there are more people living in a household then there is an increased likelihood that at least one of those people will have a car.

3.48 By contrast there is only a weak association between household composition and mileage. Belonging to a two-adult household or a household with more than two adults is negatively associated with mileage. The burden of driving could be shared more widely across people in larger households, reducing individual mileage.

Children

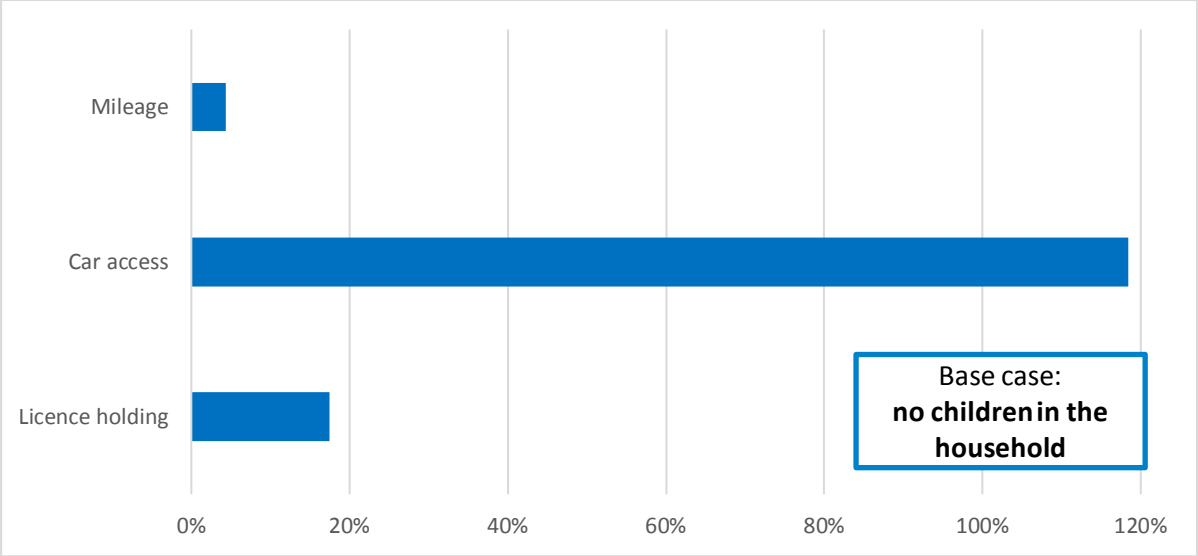

Figure 17 Relationships between having children in the household and licence holding, car access and mileage

3.49 Figure 17 shows the relationship between living in a household with children and the probability of licence holding and car access, and the average difference in miles driven, holding other factors constant. There is a positive association with the probability of licence holding, suggesting that those with children are more likely to acquire a driving licence relative to those without.

3.50 Living in a household with children is associated with a larger increase in the probability of having access to a car. This may reflect the greater need for households with children to require a car, for example when taking their children to school. The National Travel Survey suggests that car travel is the second most popular mode for taking children to school[17].

3.51 Other research[18] has highlighted the importance of life stage on car ownership, where people who start families tend to move to suburban areas where public transport is not widely available. This analysis has attempted to control for some of these effects in the regressions.

3.52 There is only a weak positive relationship between having children in a household and total mileage. This suggests that individuals living in a household with children do not drive much further than those without, provided they have a driving licence and access to a car.

[17] NTS (2014), Travel to School Factsheet, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/476635/travel-to-school.pdf

[18] Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). Young People's Travel – What's Changed and Why? Review and Analysis. Report to Department for Transport. UWE Bristol, UK. www.gov.uk/government/publications/young-peoples-travel-whats-changed-and-why

Gender

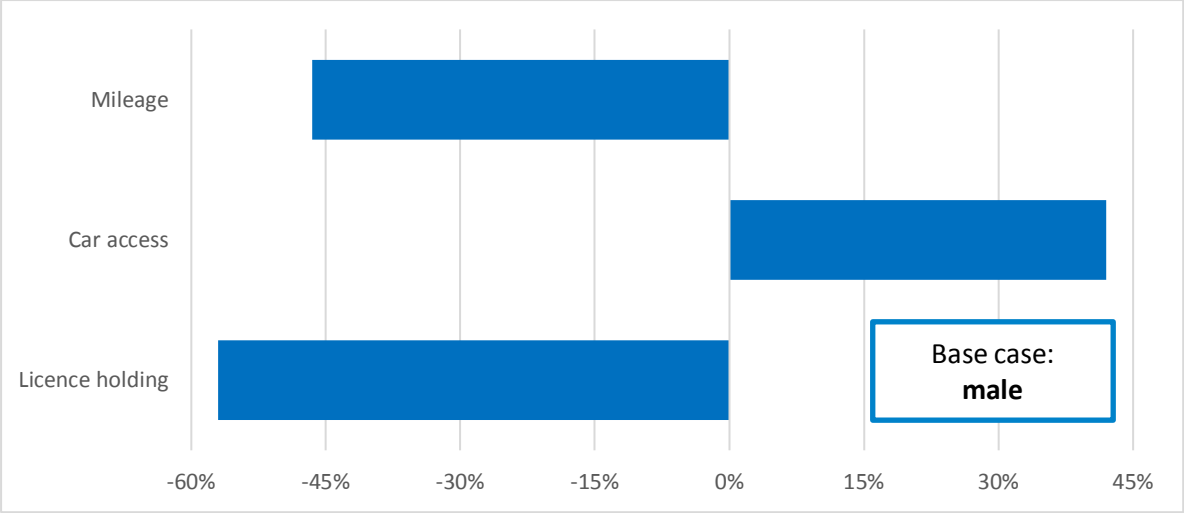

Figure 18 Relationships between gender and licence holding, car access and mileage

3.53 Figure 18 shows that relative to males, females are less likely to hold a licence, but of those who do, they are more likely to have access to a car. Similarly, of those who hold a driving licence and have access to a car, females drive half the expected mileage of males. These results assume that all other factors are held constant.

3.54 The negative licence holding and mileage results are consistent with historical evidence that suggests that females are less likely to acquire driving licences compared to men. Data from the National Travel Survey[19] has also suggested per person mileage is lower for females. This result may stem from the historically lower rates of labour market attachment for older women. Consequently, they could have less need for a car on a day-to-day basis.

3.55 The positive impact of being female on car access contrasts sharply with the mileage and licence holding results. The reasons for this could be explored in future research.

Summary

3.56 Across the three stages, there is a consistent set of factors that are influential to varying degrees. They are employment type, location, household composition and age. Therefore, these factors can be regarded as important in the decision to drive.

3.57 The factors that are associated with a significant change in the probability of licence holding are occupation type, employment type, gender, degree of urbanisation and age, though there is some variation within these categories.

3.58 The number of adults living in a household is associated with the largest changes in the probability of car access. There is also variation in the probability of car access according to job type, area of residence, gender and age.

3.59 The relationships between the explanatory variables and mileage are more consistent than for licence holding and car ownership, with almost all factors

[19] DfT (2018), National Travel Survey, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729521/national-travel-survey-2017.pdf

fluctuating within a range of -50% to 50%. The important factors here are degree of urbanisation, gender, age, occupation and employment type.

3.60 This analysis adds to the existing evidence base on car travel demand by controlling for a number of explanatory variables, enabling the regressions to isolate the relationships between each stage of driving and specific characteristics. This provides useful insight in understanding how car travel behaviour varies across the population.

4. Regional breakdown

4.1 This section provides a breakdown of the results by region. It looks at how the relationships highlighted in Section 3 vary in the North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, the South East and the South West. Since some relationships are similar across regions, this section only presents results where there was significant variation across the country.

4.2 A notable result is that socioeconomic and demographic characteristics tend to have a different relationship with the three stages of driving in London relative to the rest of the country. There tends to be greater consistency between other regions in England.

4.3 The results also illustrate the need to consider the impacts on different stages of driving by region. The large results in certain regions can explain some of the relationships found in the whole sample analysis. For example, the negative relationship between being a student and car access appears to largely stem from negative relationships in the South East and South West.

4.4 Some caution is required in interpreting these results. Both the observable and unobservable characteristics of individuals living in different regions will vary. For example, the ethnicities of people living in different regions will vary. If ethnicity is related to other variables in the analysis, such as employment status, this means that the estimated percentages may reflect both the different impacts of a factor or differences in unobserved characteristics.

4.5 These results are also not directly comparable to the primary regression results. They do not include urbanisation variables, because location types vary across regions. For example, some regions do not contain a metropolitan area, while London does not include any large urban or small urban areas, as classified in the NTS. We chose to omit these so that the regression specifications are the same for each of the regional regressions.

Employment status

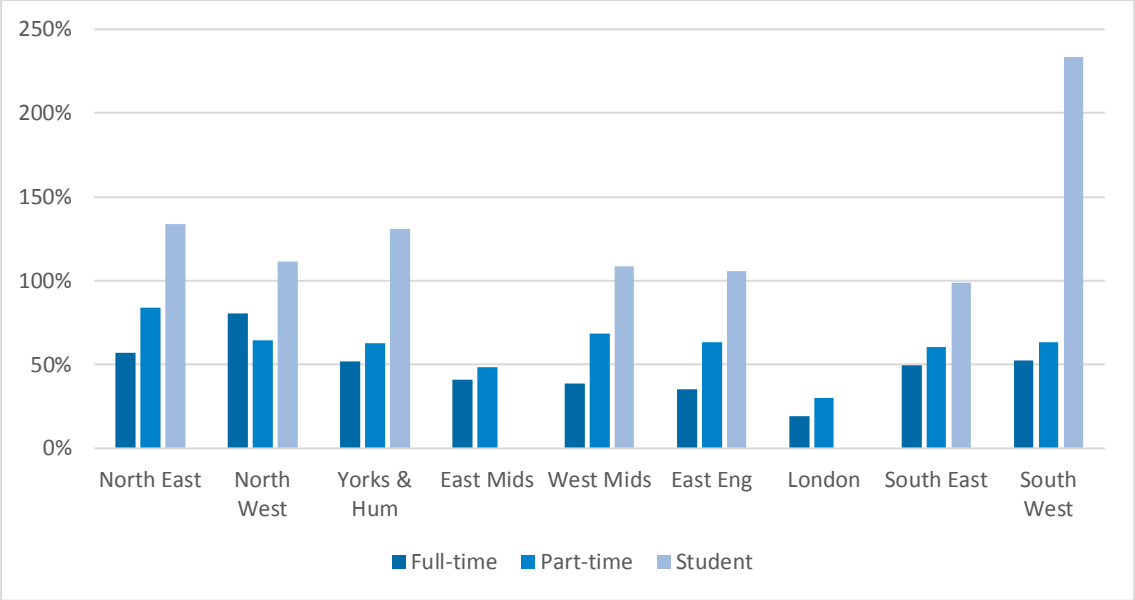

Figure 19 Relationship between employment status and licence holding by region

4.6 Figure 19 shows the relationship between employment type and licence holding by region. There is variation in the relationship between being a student and the probability of licence holding across the country. There is no significant difference in the probability of licence holding for students relative to the unemployed in London. By contrast in the South West students are over 200% more likely to hold a licence relative to the unemployed. The costs of driving are likely higher in London in terms of the congestion charge, which may be particularly acute for students relative to other categories.

4.7 There is more consistency for full-time and part-time workers in different regions. The exception is London, where being in full-time or part-time employment is only weakly associated with a higher probability of licence holding. The 2014 'Travel in London'[20] report highlighted evidence from the UK Census which showed that between 2001 and 2011 the proportion of London residents travelling to work by car fell from 36% to 25%. The lower rates of licence holding in London for full-time and part-time workers may reflect the greater susceptibility to use other modes, such as the Underground.

[20] TfL (2014), Travel in London, http://content.tfl.gov.uk/travel-in-london-report-9.pdf

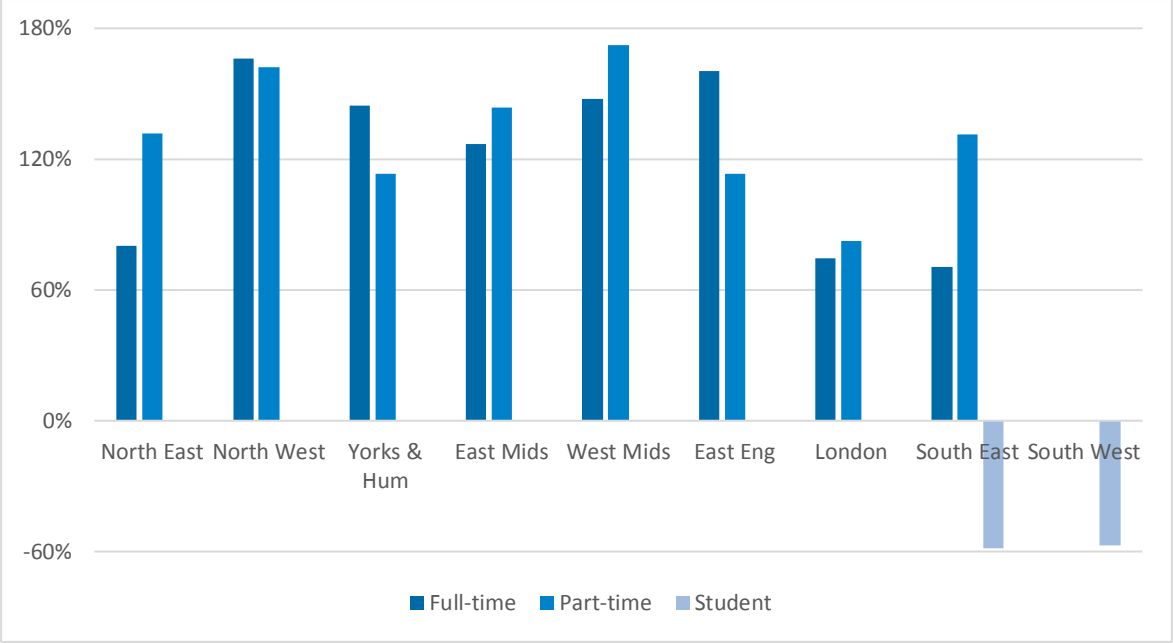

Figure 20 Relationship between employment status and car access by region

4.8 Figure 20 shows how the relationship between employment status and car access varies by region. In this instance there is greater variation across categories. Full-time and part-time workers in the South West are not significantly more likely to have access to a car relative to the unemployed, so these results are not included above. By contrast in the West Midlands the estimated association is larger. This is difficult to explain and is a potential area for further research. The student results were only significant in the South East and the South West.

Household composition

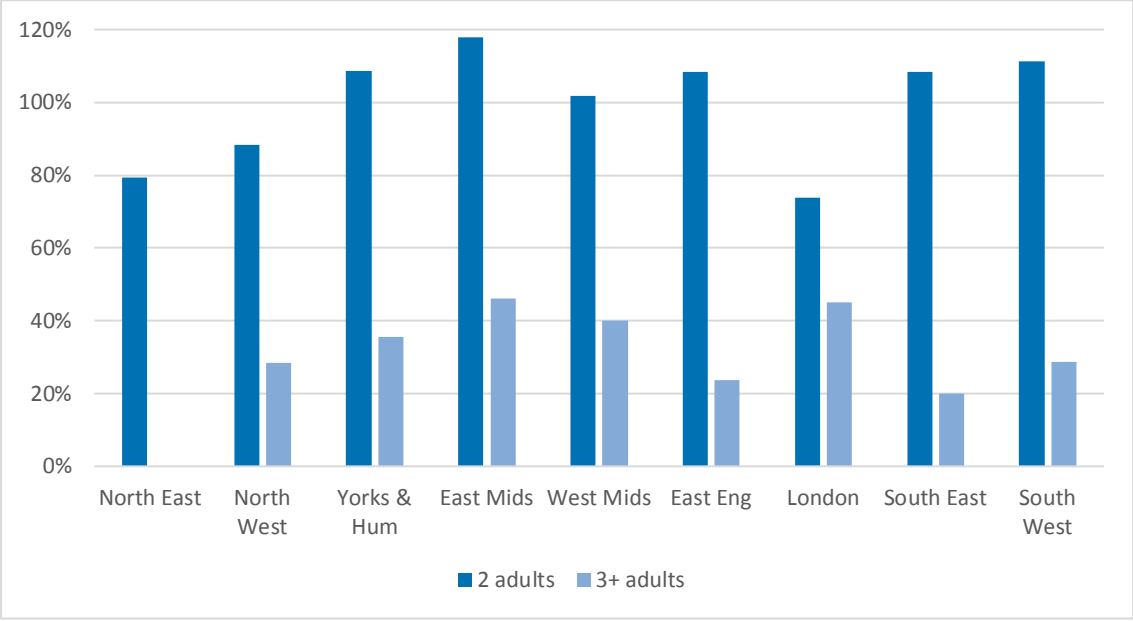

Figure 21 Relationship between household composition and licence holding by region

4.9 Figure 21 shows that there is greater regional variation in the probability of licence holding for individuals living in a two-adult household relative to belonging to a household with more than two adults. However, there is no clear pattern in the results. The probability of having a driving licence for those in a two-adult household compared to the base category is smallest in London. By contrast, individuals living in a household with more than 2 adults in the North East do not have a statistically different probability of licence holding relative to the base case.

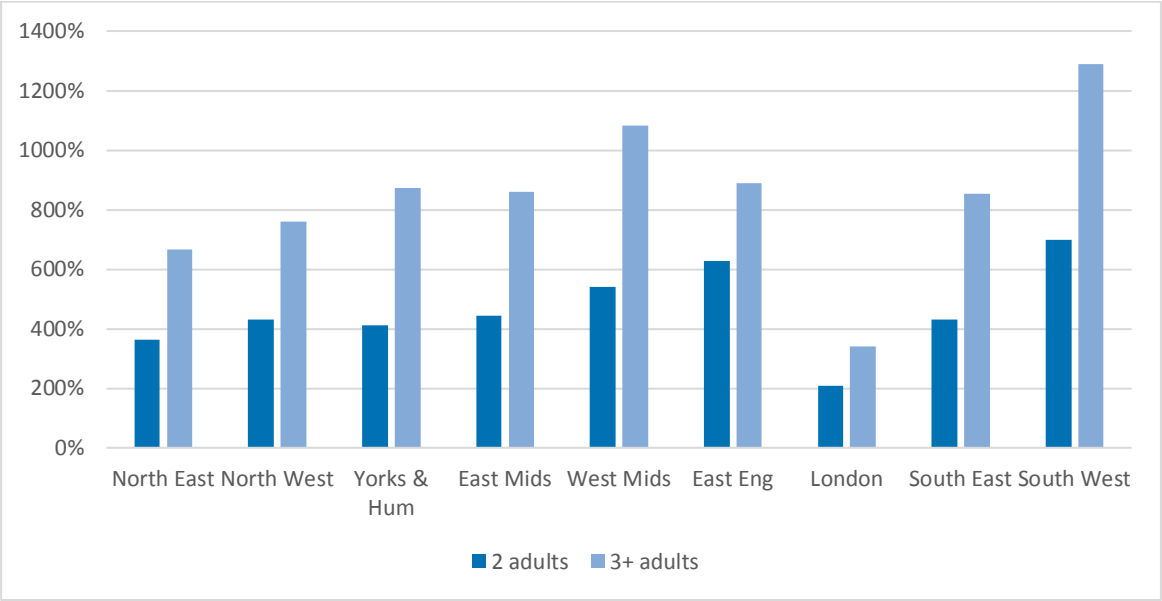

Figure 22 Relationship between household composition and car access by region

4.10 Conversely the smallest probabilities of car access result from belonging to a two-adult household or a household with more than two adults in London.

4.11 Compared to the licence holding results the difference in the probability of car access between those living in a household with two adults or more than two adults is larger. This indicates that car access is more variable with respect to the number of adults living in a household.

4.12 In 3.47 the magnitudes for household composition were indicated to be the largest in the entire analysis. While the associated impacts of living in a household with two or more adults are found to generally be large across regions, this appears to be particularly the case in the West Midlands and the South West.

Figure 23 Relationship between household composition and mileage by region

4.13 The mileage results are inconsistent with the other household composition results. They show that living in a household with more adults is associated with a negative effect on mileage.

4.14 There is greater consistency in these results, with little difference depending on whether you live in a household with either two adults or more than two adults. The exceptions to this are the West Midlands and London, where the negative impacts are larger than in other regions.

Occupation type

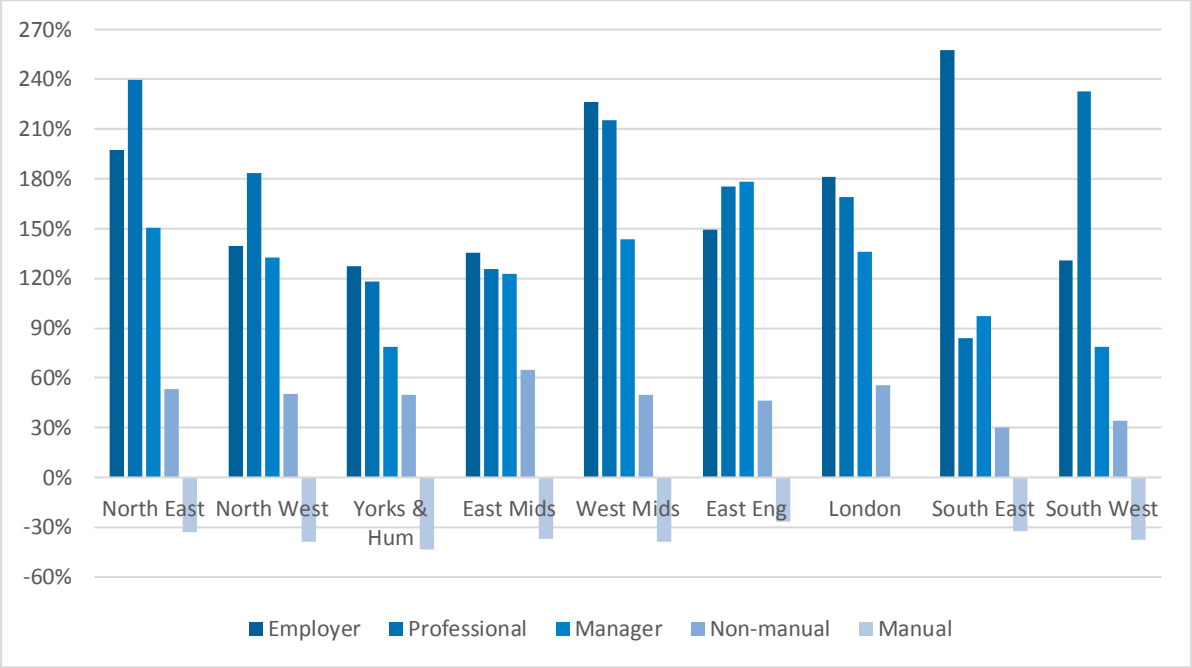

Figure 24 Relationship between occupation type and licence holding by region

4.15 Figure 24 shows the relationship between licence holding and occupation type in different areas. The base case for the results in each region is unskilled workers within the same region.

4.16 The relationship between occupation type and the probability of licence holding varies significantly between regions. Employers in the South East are much more likely to hold a driving licence relative to unskilled workers within the same region. By contrast in the South West being a professional worker is associated with the highest probability of holding a driving licence. There is also a strong impact in the North East and the West Midlands.

4.17 Being a manual worker generally leads to a lower probability of licence holding, relative to the base case. The exception to this is in London, where there is no significant impact. These results may partly reflect differences in motoring costs across regions, for example if insurance costs varied between them.

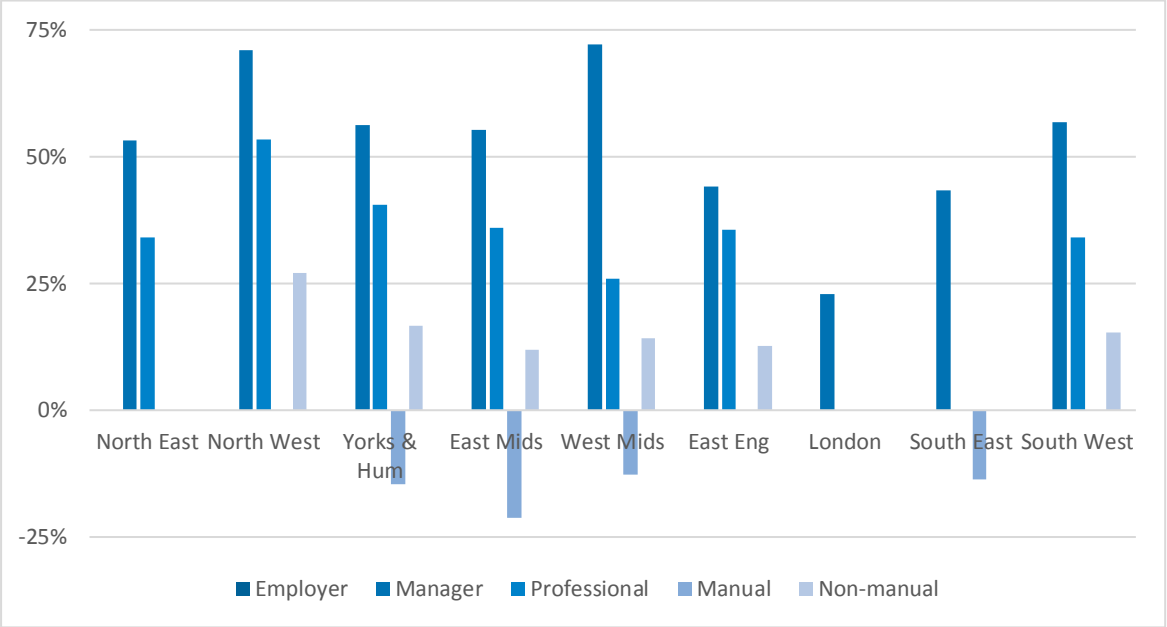

Figure 25 Relationship between occupation type and mileage by region

4.18 The results for car access did not show many significant results, so are not displayed here. However, Figure 25 shows the relationship between occupation type and mileage across different regions. London has the smallest measured impacts, with only manager being significantly related to differences in mileage relative to the base case. By contrast being a manager in the North West and the West Midlands are associated with the greatest changes in expected mileage relative to the base case.

Children

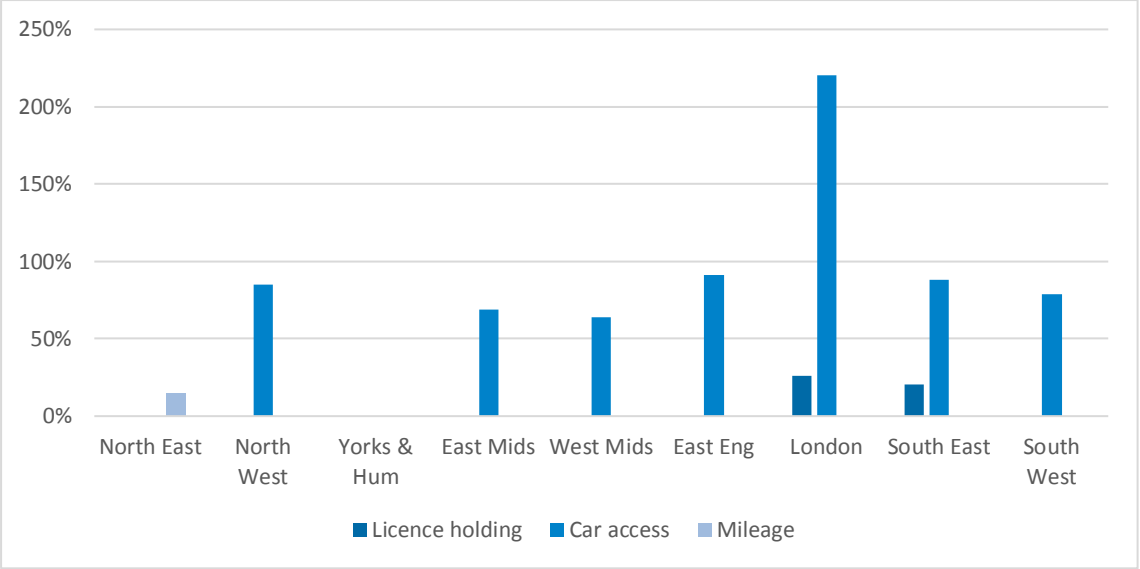

Figure 26 Relationships between having children in a household and licence holding, car access and mileage

4.19 Figure 26 shows the regional variation in the relationship between living in a household with children and licence holding, car access and mileage. The small positive association between living with children and mileage appears to be driven by the effect in the North East, which is the only significant impact for the different regions.

4.20 There is greater variation in the probability of car access across the country. This is particularly evident in London, where an individual living with children is over 200% more likely to have access to a car than somebody living in a household without children. By contrast there is no significant effect in the North East or Yorkshire & the Humber. This may reflect the greater reliance of cars in those regions, so that having children does not provide further impetus to invest in one.

4.21 The London results are consistent with evidence in TfL's Roads Task Force[21], which found that people in a household with children are nearly a third more likely to have a car than those without. Although the estimated effects on the probability of car access in this report are larger, the regressions control for other characteristics to isolate the specific impact of having children in London. This means the percentages are not directly comparable.

[21] TfL (2013), Roads Task Force Technical Note 12, http://content.tfl.gov.uk/technical-note-12-how-many-cars-are-there-in-london.pdf

5. Age breakdown

5.1 This section provides a breakdown of the factors affecting the different stages of driving by age. The results presented are those where there was the greatest variation across age groups.

5.2 Generally, the results find that factors have differential effects on younger and older age groups. The strongest relationships are found for car access, although licence holding also exhibits significant variation by age group for some variables. The impacts are weaker and less variable for mileage, so these results are not discussed.

5.3 One notable result is that the difference between male and female drivers is greatest for the age 65+ category, and smaller for younger age categories. This indicates that gender disparities in driving behaviour may be decreasing.

Employment status

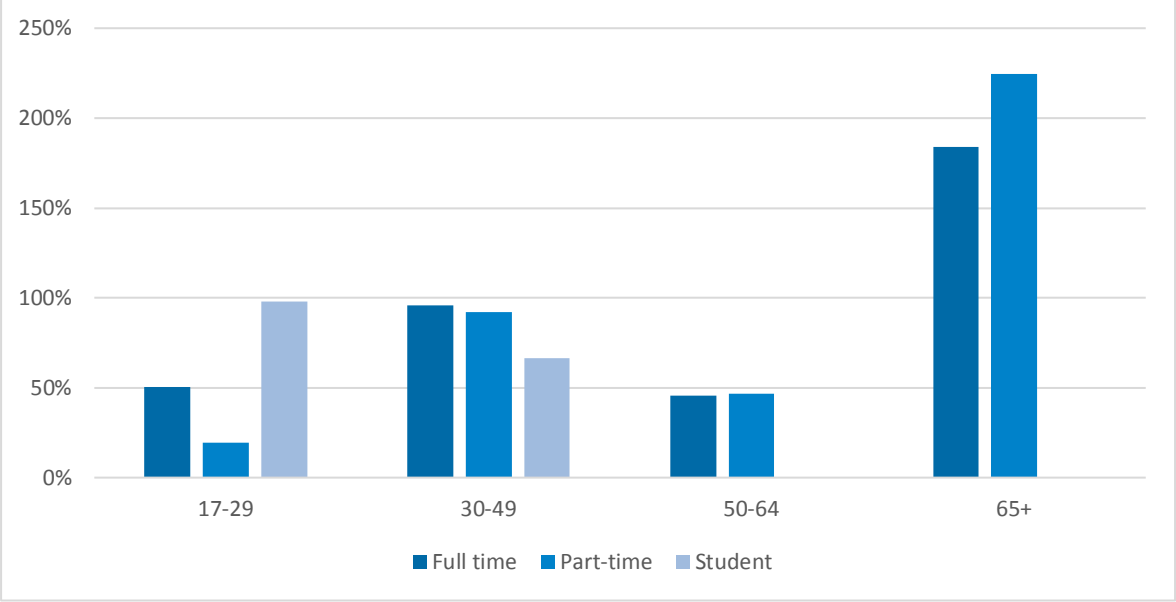

Figure 27 Relationship between employment status and licence holding by age group

5.4 The relationships between employment type and licence holding are strongest for the 65+ age group. Being a part-time worker is associated with more than a 200% higher probability of holding a driving licence relative to being unemployed. Evidence in 'Commuting Trends in England'[22] suggested that car travel is the most popular form of commuting mode for all adult types, but particularly for males and females aged 60-69. This means the high rates of licence holding for part-time and full-time workers

[22] Le Vine, S., Polak, J. and Humphrey, A. (2017) Commuting trends in England 1988 – 2015, Department for Transport

aged 65+ may reflect their higher propensity to drive, relative to other individuals aged 65+ who no longer work.

5.5 The weakest relationships between employment status and the probability of licence holding occur for the 17-29 age group. However, students aged 17-29 are more likely than those aged 30-49 to have a driving licence relative to the unemployed. The 17-29 and 65+ categories are also the only ones where there is a discernible difference in the relative probabilities of licence holding between full-time and part-time workers.

5.6 An additional notable point is the magnitude of impacts for full-time and part-time work reverse for people in higher age categories. Younger individuals have a higher probability of licence holding if they are in full-time work, whereas for older individuals the probability is higher in part-time work. The reasons for this remain unclear.

5.7 These results indicate that the positive relationship between being a student and the probability of licence holding in the whole sample analysis can mainly be attributed to the 17-29 age group. By contrast the results for full-time and part-time workers may in part reflect the higher probability of licence holding for the 65+ category.

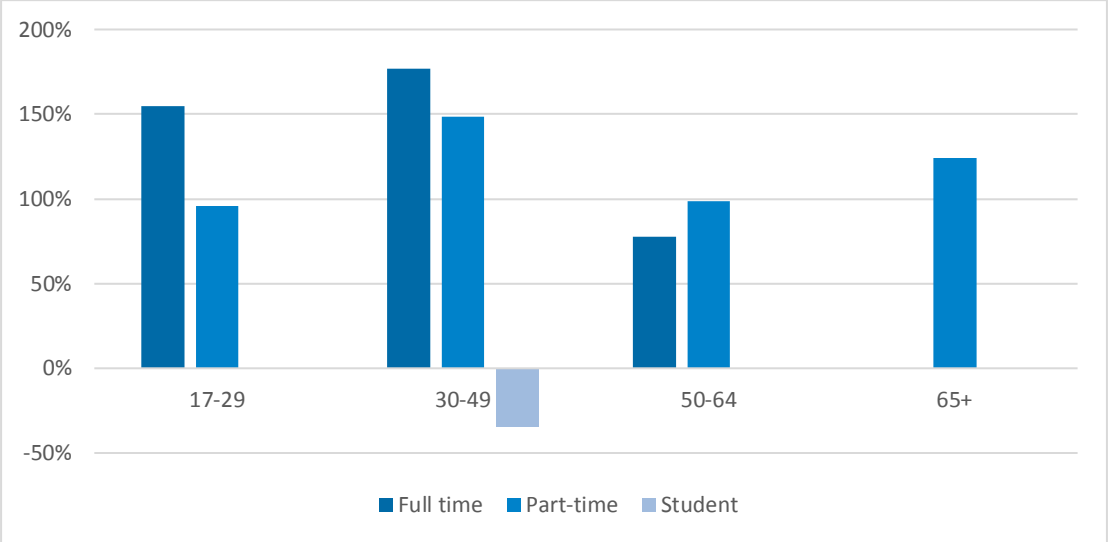

Figure 28 Relationship between employment status and car access by age group

5.8 For car access the results show that individuals aged 17-29 are more likely to have access to a car if they are in full-time work, or part-time work. The largest positive probabilities occur for full-time and part-time workers aged 30-49, relative to unemployed individuals of the same age. These results may be consistent with the finding in Young People's Travel, which found stable employment was a strong predictor of car use for younger people.

5.9 Consistent with the licence holding regressions the associated effect of being in full-time employment on car access is larger than for part-time employment at younger ages. This pattern reverses for older age categories.

Occupation type

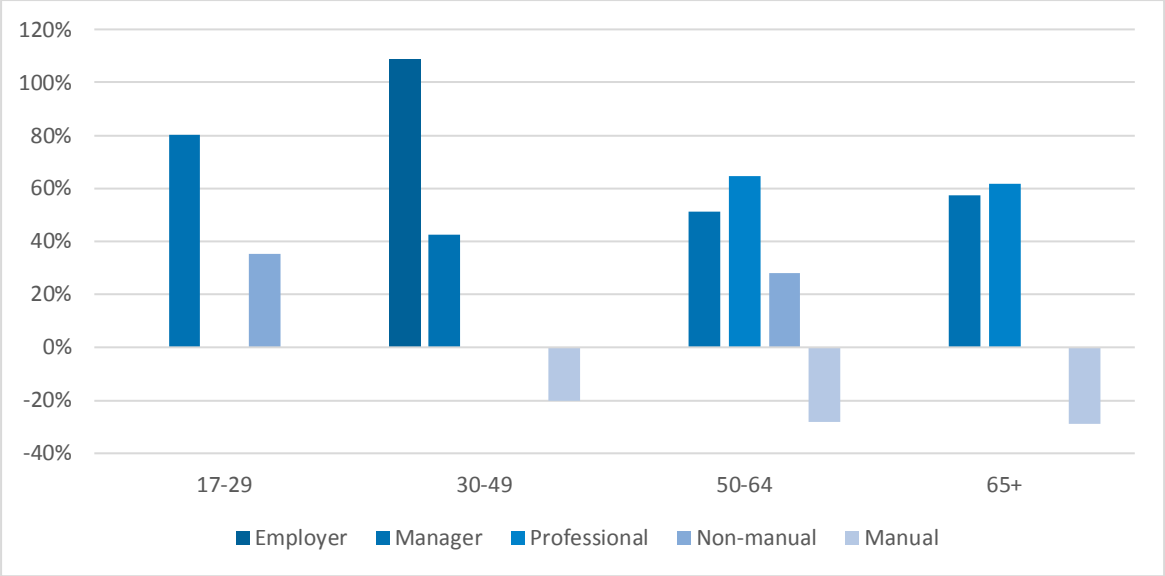

Figure 29 Relationship between occupation type and car access by age group

5.10 The results show that the probability of car access by occupation type varies according to age. Being a manager is associated with the highest probability of car access for the 17-29 age group, while being an employer only has a significant association with car access for the 30-49 age group.

5.11 The relationship between being a non-manual worker and car access is similar for the 17-29 and 50-64 age groups. Relative to the base category, non-manual workers of these ages are approximately 30% more likely to have access to a car.

5.12 There is greater consistency in the association between occupation type and the probability of car access for the 50-64 and 65+ age groups. For example, being a manager appears to have a similar impact on the probability of car access for the 50-64 and the 65+ groups. This indicates the estimated effect of occupation type is more stable for those over 50.

5.13 This evidence may partly reflect how motoring costs change as people age. For example, professional workers aged 17-29 may experience relatively lower motoring costs relative to those in older age groups. This means that younger groups in these occupations find it relatively easier to afford using a car.

Household composition

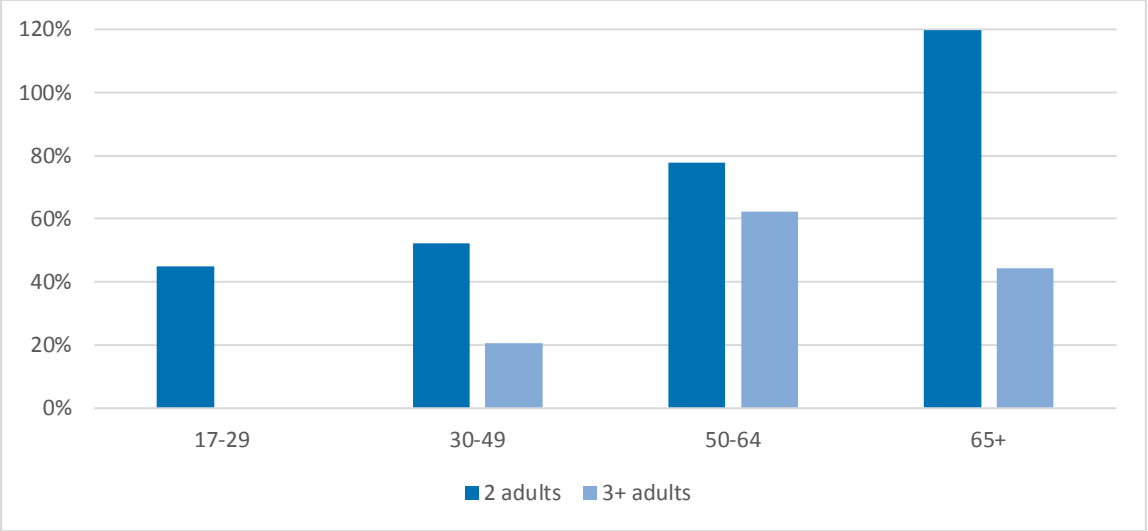

Figure 30 Relationship between household composition and licence holding by age group

5.14 The number of adults living in a household has the greatest associated effects on licence holding for the 65+ age group. For this group, living in a household with two adults is associated with a 120% higher probability of licence holding relative to those who live on their own.

5.15 Living in a household with more adults appears to generally have a larger associated impact on the probability of licence holding as people age. Household composition leads to less variation in the probability of licence holding for the 17-29 age range.

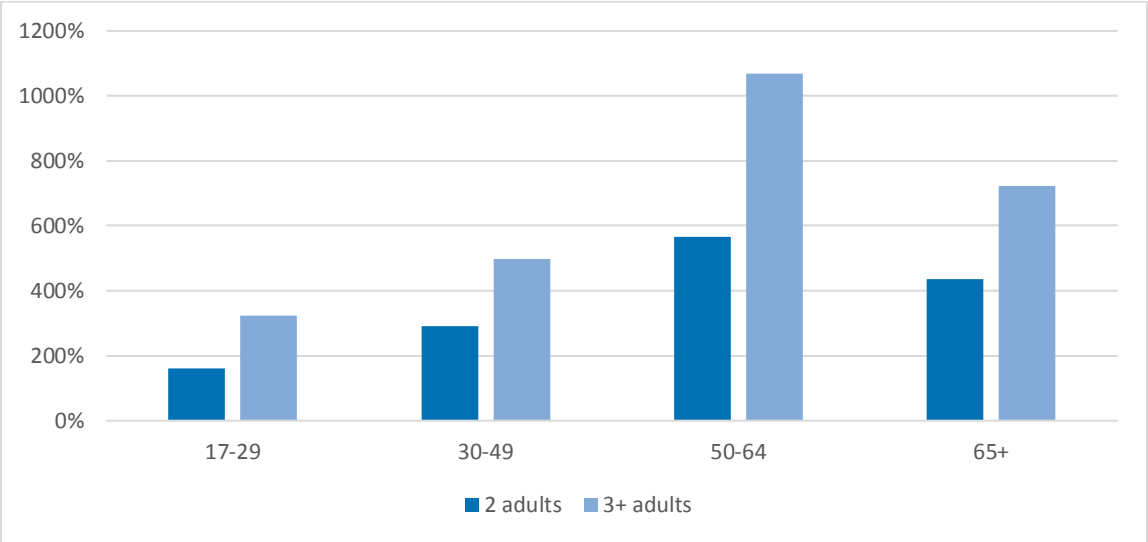

Figure 31 Relationship between household composition and car access by age group

5.16 Consistent with earlier in the analysis, the largest associated impacts in the analysis occur for the effect of household composition on car access. This is particularly the case for the 50-64 age bracket, where living in a household with two or more adults is associated with an 11-fold increase in the probability of having access to a car. The smallest increases occur for the 17-29 age group.

5.17 The higher relative probabilities of car access for those aged 65+ age who live in households with more adults may reflect people's propensity to forego cars as they age[23]. This means those living in single person households may no longer have car access, while those living in larger households can still access the vehicles of other adults living with them.

Gender

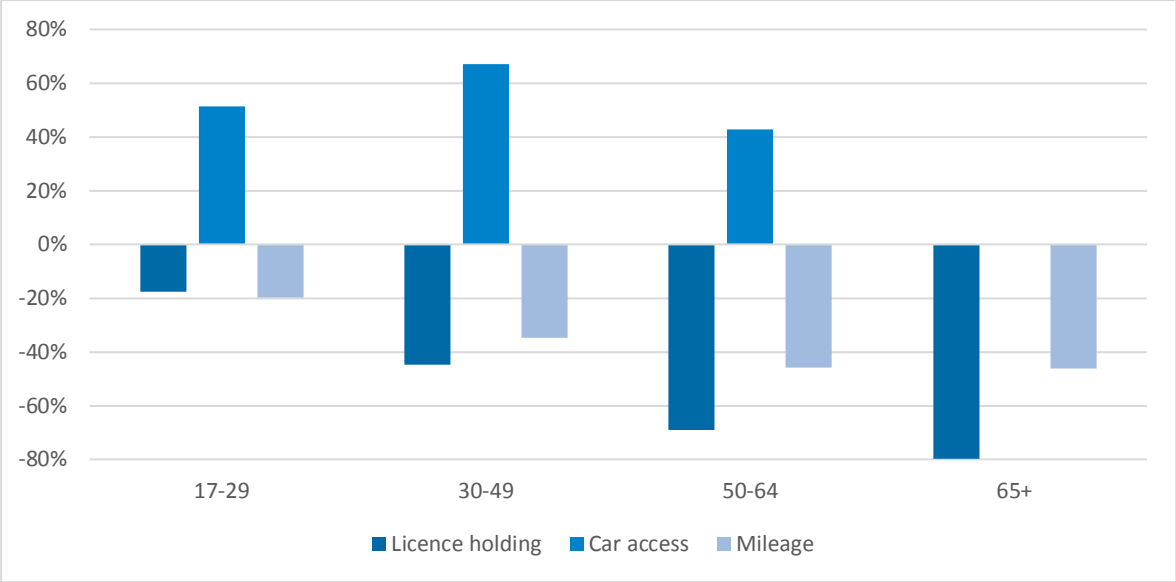

Figure 32 Relationships between gender and licence holding, car access and mileage by age group

5.18 Figure 32 shows the relationship between being female and the probability of licence holding and car access, and the associated impact on average mileage across age ranges. Younger women show similar patterns of licence holding and mileage to men in the same age group. By contrast, older women are much less likely to hold a driving licence, and drive fewer miles than men in the same age range.

5.19 There is no clear pattern to the car access results. However, generally women of a given age are more likely to have access to a car than men of the same age, holding other factors constant.

5.20 The licence holding results are consistent with recent work in Young People's Travel, which indicated that for younger people females are catching-up with males in terms of licence holding. This pattern has also been reaffirmed in the 2017 National Travel Survey[24], which showed a significant narrowing in the proportion of licence holders among males and females between ages 17 and 20.

5.21 The differences between age groups may reflect how younger women have a greater need to travel by car. For example, greater labour market attachment among younger women means that they may require cars for commuting and work activities. Such a phenomenon could account for the narrowing gap in mileage and licence holding between men and women in younger categories.

[23] TfL (2013) Roads Task Force - Technical Note 12, http://content.tfl.gov.uk/technical-note-12-how-many-cars-are-there-in-london.pdf
[24] DfT (2018), National Travel Survey, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729521/national-travel-survey-2017.pdf

6. Changing trends in factors affecting travel

6.1 Earlier in the analysis household composition and employment status were highlighted as being particularly important in explaining differences across the three stages of driving. Similarly, age, income and location are frequently cited as explaining recent travel trends. This section shows how the results have changed over the sample period.

6.2 One of the most significant results relates to income. Incremental changes had less impact on the probability of licence holding in 2007-12 than they had in 1995-2000. The results also highlight that income is associated with lower levels of mileage than in the past. This is consistent with evidence in UDRT that the relationship between income and car use has weakened over time.

6.3 Evidence also shows those aged 17-29 have become less likely to hold a driving licence relative to individuals aged 65+. This is consistent with more recent evidence showing younger cohorts have become less likely to acquire driving licences over time.

6.4 However, some caution is required when interpreting the results for age, employment, occupation type and household composition. The base case statistics change in each time split, meaning that the results do not provide a like-for-like impact. In practice the proportion of licence holders, those with car access and miles driven by the base case will be different in each time split. This means they only show how the relative impact of each factor changes.

Income

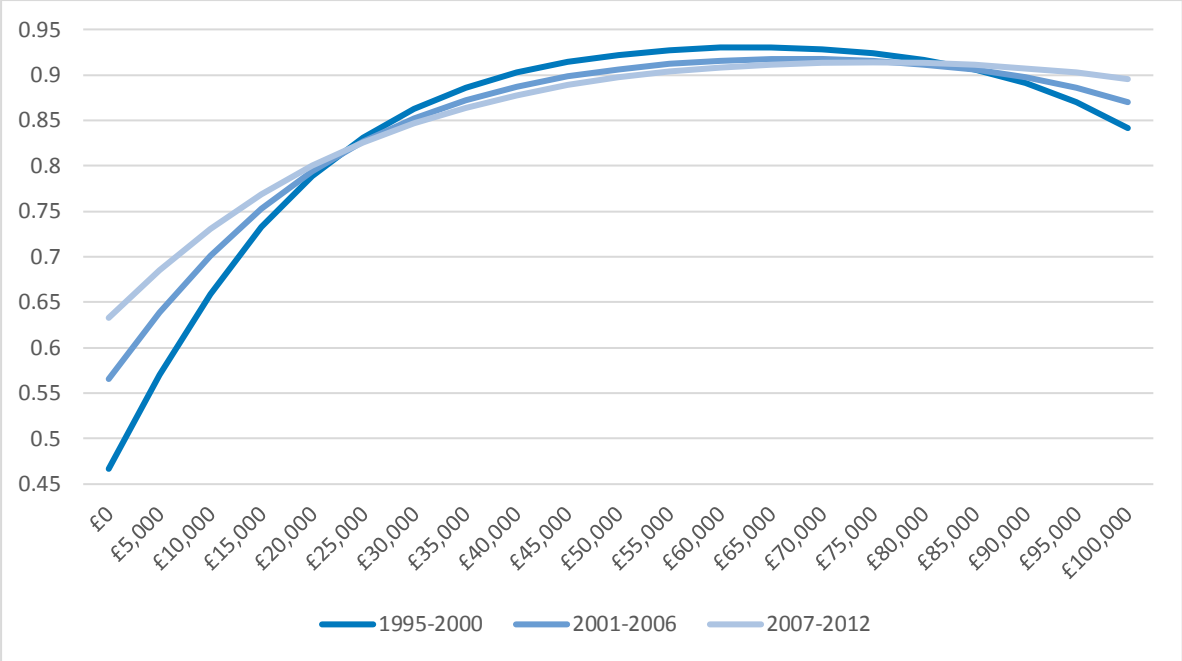

Figure 33 Predicted probabilities of licence holding at different levels of income for the base case from 1995-2000 to 2007-2012

6.5 Figure 33 shows that by 2007-12 having £0 of income is associated with a higher predicted probability of licence holding. However, as income increases the marginal change in the predicted probability of licence holding is smaller.

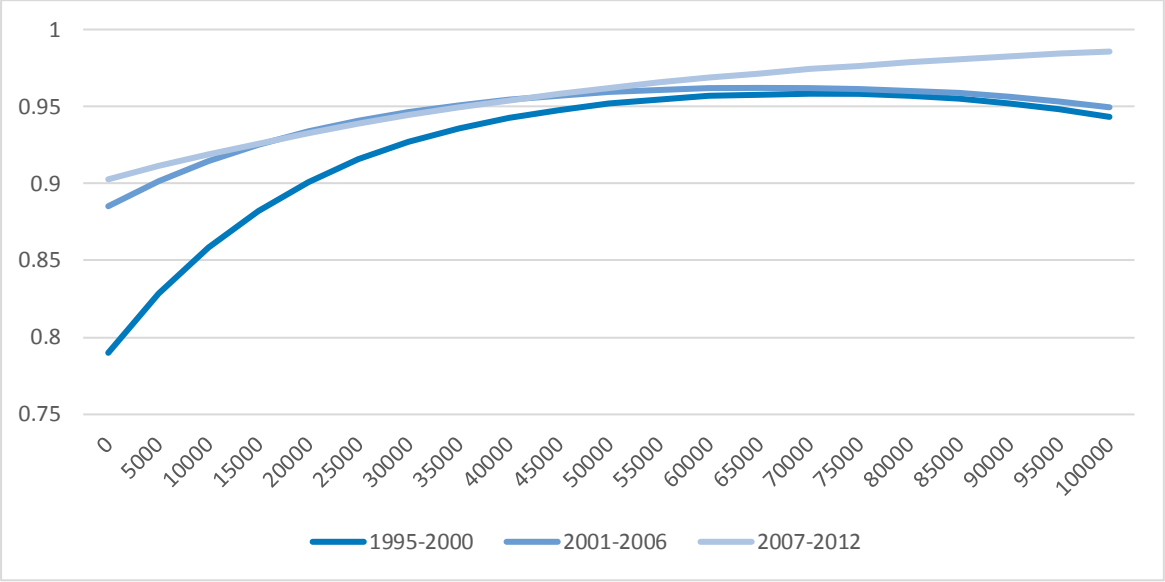

Figure 34 Predicted probabilities of car access at different levels of income for the base case from 1995-2000 to 2007-2012

6.6 Similarly Figure 34 shows the relationship between income and the predicted probability of car access has strengthened between 1995-2000 and 2007-12. Here there is no longer a turning point, implying that incremental increases in income have not been associated with a lower probability of car access in recent years.

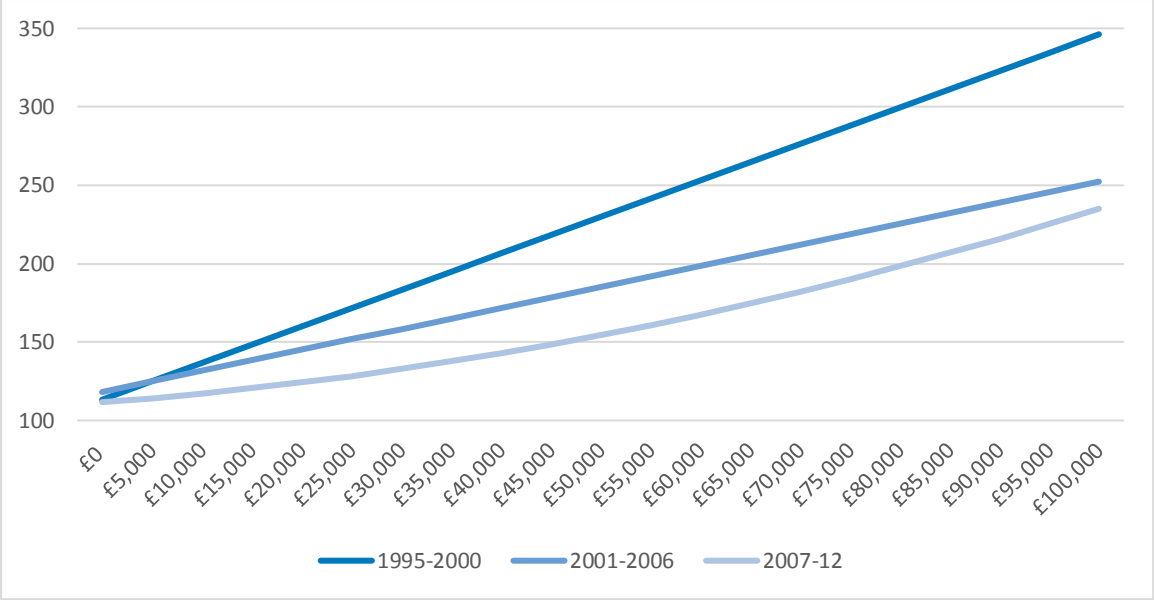

Figure 35 Changes to the impact of income upon expected mileage from 1995-2000 to 2007-2012

6.7 Figure 35 shows how the correlation between income and expected mileage has changed over time. There has been a clear shift downwards, implying that higher incomes are associated with lower levels of expected mileage.

6.8 These results are consistent with evidence elsewhere that the relationships between income and measures of car usage have weakened over time. The evidence in Figure 35 is also consistent with a recent report[25] which showed that individuals with higher levels of income are no longer driving as much as they did in the past.

6.9 Nonetheless it remains unclear whether the results for the 2007-2012 period reflect the negative impacts of the 2008 recession. If the recession increased unemployment and reduced people's capacity to afford a car then the impact may be temporary, and could reverse as the economy recovers. This should be an area for further research as more data becomes available.

[25] Marsden, G. et al. (2018) All Change? The future of travel demand and the implications for policy and planning, First Report of the Commission on Travel Demand, ISBN: 978-1-899650-83-5

Age

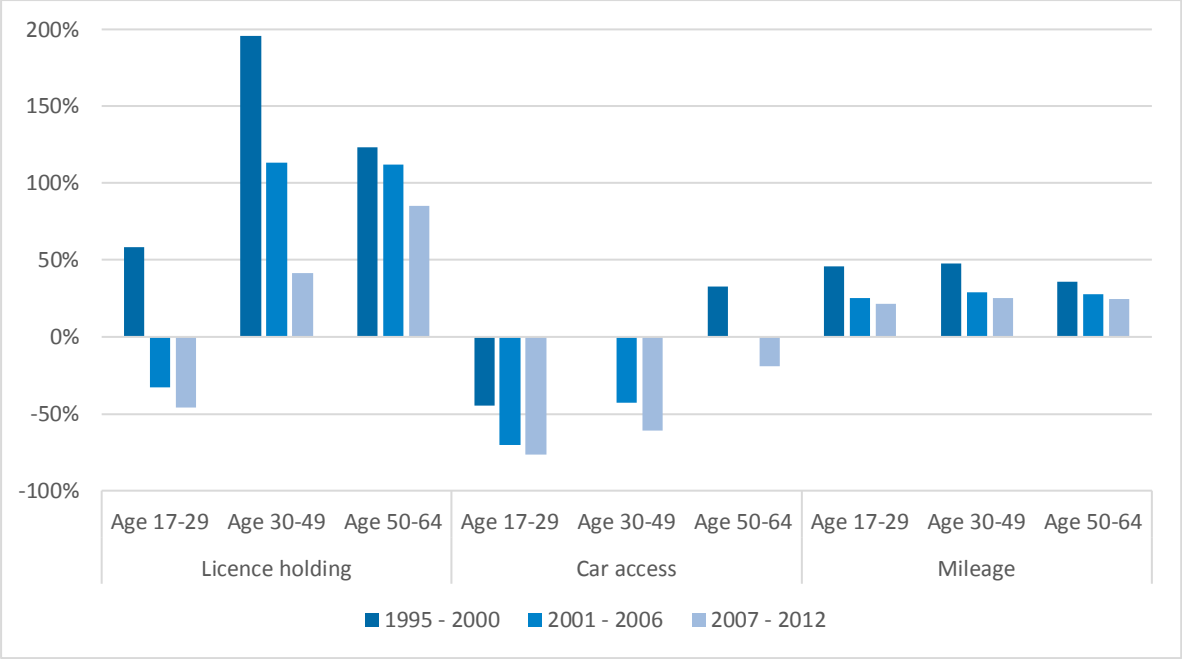

Figure 36 Changes in the relationships between age and licence holding, car access and mileage from 1995-2000 to 2007-2012

6.10 The licence holding results show that the differences between those aged 30-49, 50-64 and 65+ have diminished over time. However, for ages 17-29 the relationship has reversed from positive to negative. This may be indicative of fewer young people acquiring driving licences.

6.11 For car access the associated impact of age has become increasingly negative for all groups relative to the 65+ age group. The effects are larger for younger age categories, which is consistent with other evidence suggesting the propensity of young people to drive has fallen.

6.12 By contrast the associated effects for mileage have remained positive for all categories relative to those aged 65+. However, the differences compared to the base group has fallen over time. In recent years the gap in total miles driven has narrowed between all age groups.

Employment status

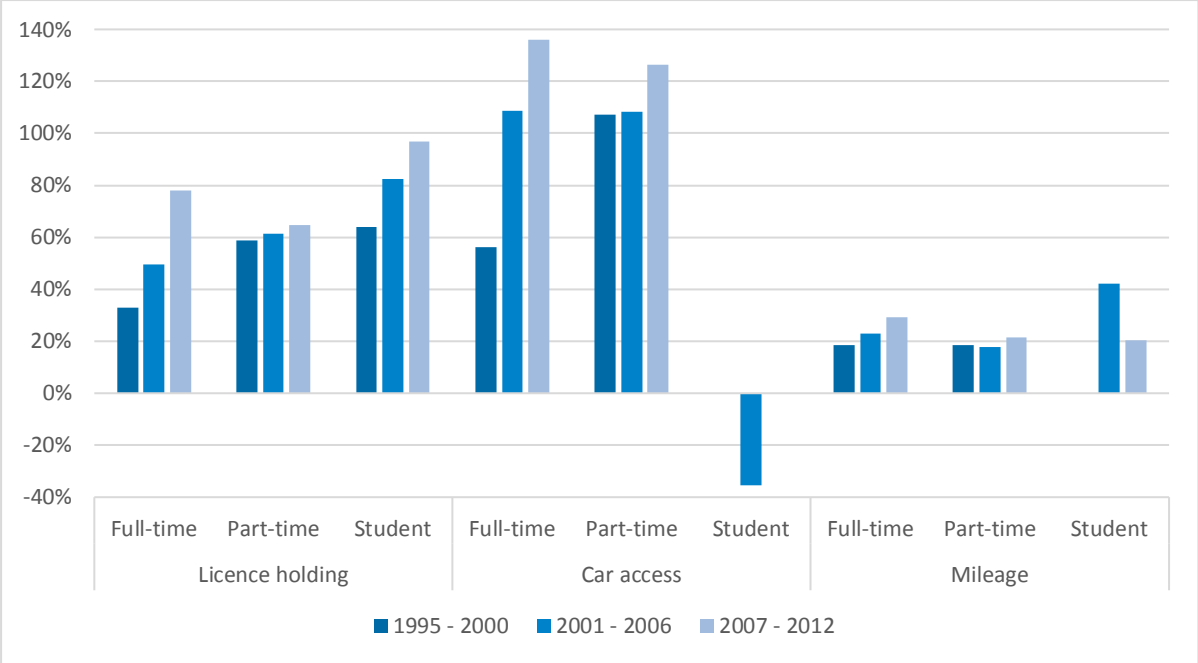

Figure 37 Changes in the relationships between employment status and licence holding, car access and mileage from 1995-2000 to 2007-2012

6.13 Figure 37 shows the relationship between employment status and the three stages of driving has become more influential over time. For both licence holding and car access the impact of being a full-time worker has more than doubled between 1995 – 2000 and 2007-2012.

6.14 The smallest associated effects are found for mileage, where different patterns are exhibited across employment statuses. While being a full-time worker has become associated with higher mileage over the sample period (relative to the unemployed), for part-time workers the effect has remained more stable. It is difficult to discern a pattern for students due to the insignificant coefficient in 1995 – 2000.

6.15 The results highlight that being a student has a different associated impact across the stages of driving. Compared to the unemployed, they have become more likely to hold a licence over time, less likely to have access to a car, but conditional on car access and licence holding still drive further.

Location

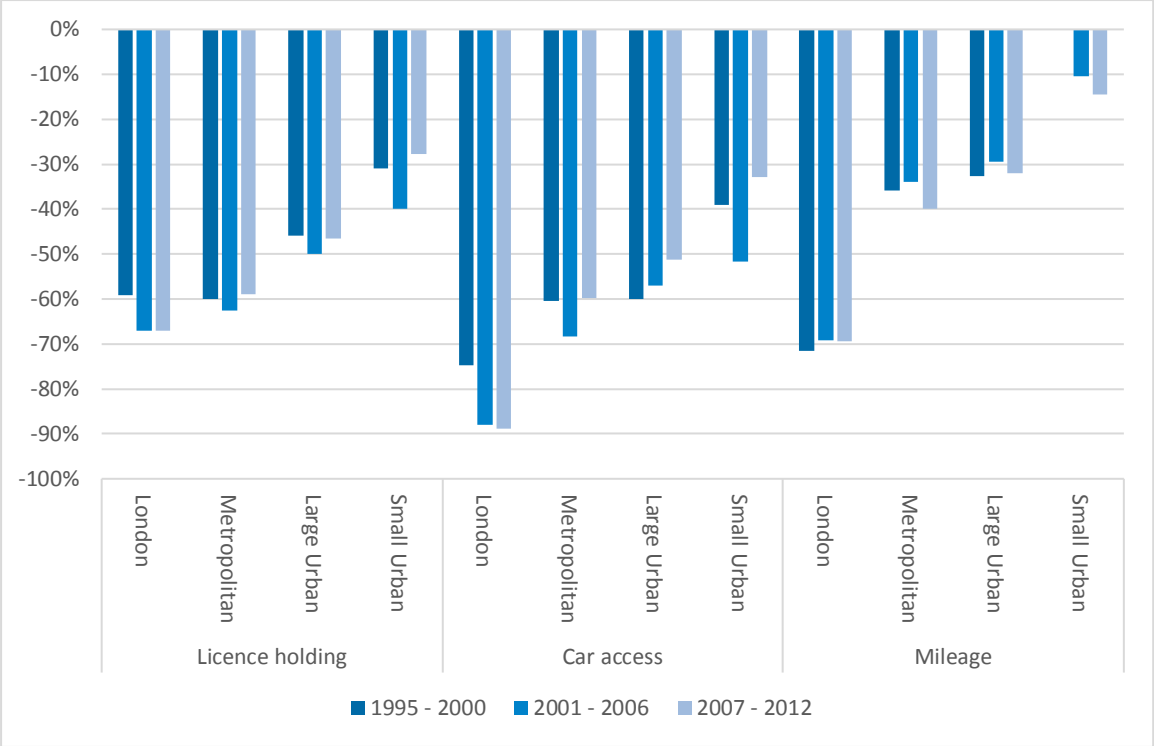

Figure 38 Changes in the relationships between location type and licence holding, car access and mileage from 1995-2000 to 2007-2012

6.16 Figure 38 shows how the relationship between location and the three stages of driving has changed across the sample splits.

6.17 The relationship between location and the three stages of driving has remained stable over time. This is even the case in London and metropolitan areas, where policies have been enacted to reduce congestion.

6.18 These results are useful since they highlight that the effect of the location variables in the main regressions does not reflect a recent sudden change in the relationship. It appears persistent, and can perhaps be attributed to local characteristics.

Household composition

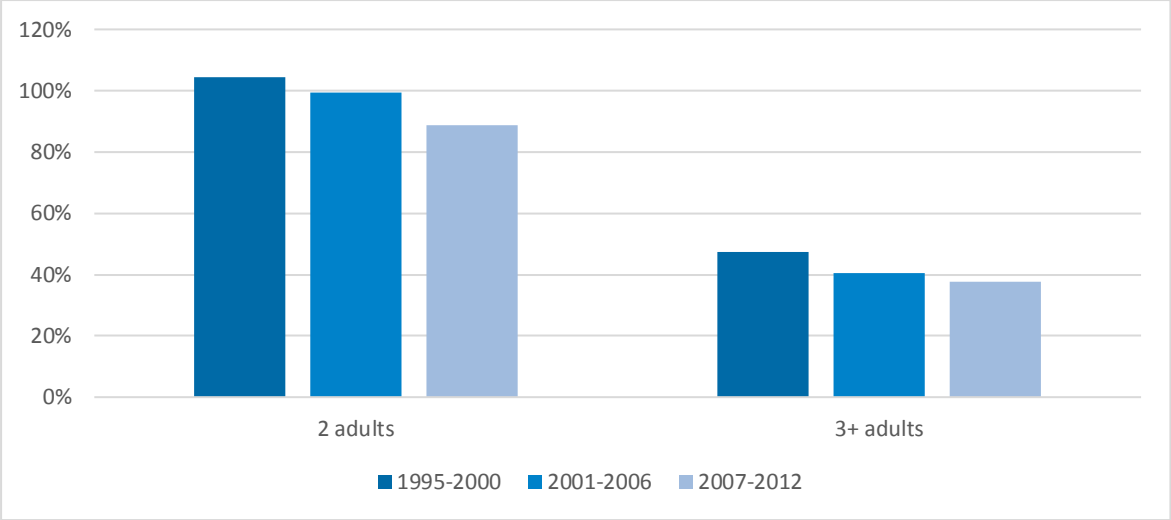

Figure 39 Changes in the relationship between household composition and licence holding from 1995-2000 to 2007-2012

6.19 The correlation between household composition and licence holding appears to have declined. This is most evident for the relationship between living in a household with two adults. Despite this, throughout the sample period those living in a household with either two adults or more than two adults remain significantly more likely to hold a driving licence than those living in a one-adult household.

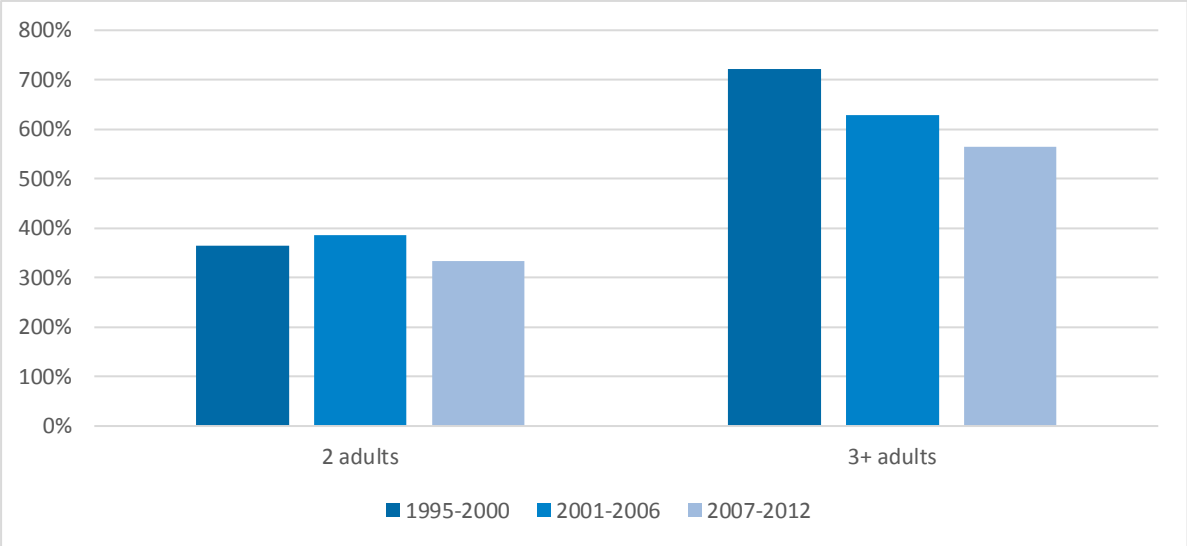

Figure 40 Changes in the relationship between household composition and car access from 1995-2000 to 2007-2012

6.20 The results for car access are more stable for those belonging to a household with two adults, implying that relative to the base category there has been little change in the probability of these individuals having access to a car. By contrast, there has been a greater decline in the probability of car access for those living in a household with more than two adults.

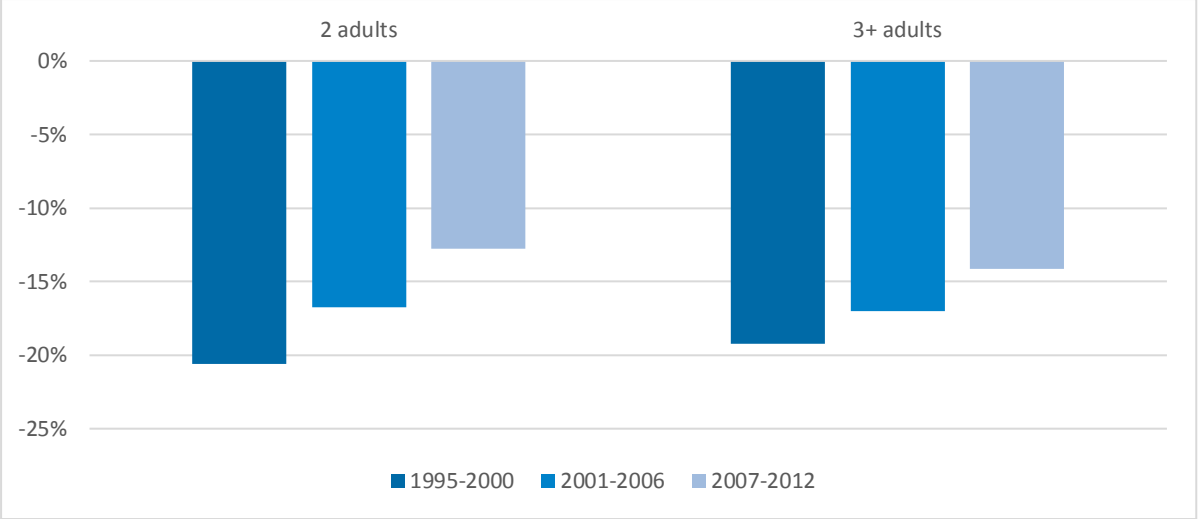

Figure 41 Changes in the relationship between household composition and mileage from 1995-2000 to 2007-2012

6.21 There is a disparity between the mileage results and the other stages for household composition. The estimated magnitudes for mileage remain considerably smaller, but like the other results the magnitude of impacts have decreased.

6.22 Overall these results are indicative of household composition having a diminishing effect on the three stages of driving. However, it remains significant in explaining the probability of licence holding and car access, even though the mileage results are significantly smaller. This highlights the importance of distinguishing between the different stages of driving.

7. Exploring interdependencies between factors

Understanding interdependencies between factors

7.1 Thus far, the analysis has assumed that the demographic and socioeconomic factors included in the regressions are unrelated to each other. By contrast this section explores whether there are interaction effects between age and location. For example, it shows whether there is a difference in the relationship between age and the probability of licence holding for an individual aged 17-29 who lives in London, relative to a 17-29 year old who lives in a metropolitan area.

7.2 Interaction variables help capture non-linear impacts. Travel demand is a difficult phenomenon to quantify, and in practice there are likely to be many interaction effects that could be captured. However, this framework is unable to capture all interaction terms since there are already a large number of explanatory variables in the regressions. This analysis focuses on the interactions between age and area, since these were found to be most significant when the model was being tested.

7.3 Interaction terms are also useful because they help reduce heteroscedasticity in the logistic regressions, which can be a source of specification error in such models.

Interaction between age and location

		Licence holding	Car access	Mileage
Age 17-29	London	Yes	Yes	Yes
	Metropolitan	No	No	Yes
	Large Urban	No	No	Yes
	Small Urban	No	No	No
Age 30-49	London	Yes	Yes	Yes
	Metropolitan	Yes	No	Yes
	Large Urban	Yes	No	Yes
	Small Urban	Yes	No	No
Age 50-64	London	Yes	Yes	Yes
	Metropolitan	Yes	Yes	Yes
	Large Urban	Yes	Yes	Yes
	Small Urban	No	No	No

Figure 42 Significance of age-location interaction variables in the licence holding, car access and mileage regressions

7.4 Figures 42 shows which interaction terms were significant. Throughout each regression the terms for London are significant. This means, for example, that a 17-29 year old living in London exhibits different travel behaviour to a 17-29 year old living in a rural area. By contrast, the results imply that people of a given age living in a small urban area do not exhibit significantly different behaviour to people of the same age living in a rural area.

7.5 The results also highlight that individual mileage is the stage of driving where interaction effects are most relevant. The effects are generally insignificant for car access, where only individuals aged 17-29 and 30-49 exhibit a statistically significant difference in mileage relative to the base case.

Changes to other coefficients

7.6 The magnitude and significance of other variables also changed when including interaction variables. This is possible if the interaction variables in part capture the effects of other variables in the analysis. However, in practice there were only small changes in other estimated coefficients. This suggests that the model used in Section 3 is well specified. Both the magnitude of the estimated interaction effects and the changes to other variables are available in Annex C.

8. Conclusion

Summary of methodology

8.1 This report has quantified the importance of socio-economic and demographic variables upon the decision to hold a driving licence, the decision to own / share a car (car access), and how far to drive (mileage). A three-staged regression was used, with the first two stages using a binary logistic regression, and the third a multivariate regression.

8.2 Further regressions were undertaken where the sample was broken down by region of residence, age group, and time period. Interaction terms were also introduced to help improve the model, and attempt to understand some of the underlying interactions.

8.3 The logistic regression results show how the probabilities of licence holding and car access have changed with respect to a base case. The mileage results indicate how changes in socio-economic factors explain relative differences in miles driven.

Summary of findings

8.4 Key factors which influence people's decisions around car travel are employment type, household composition, location and age.

8.5 An overarching trend of the analysis is that the probability of holding a driving licence, and having access to a car tends to be lower in London relative to the rest of the country. The analysis also finds that the total number of miles driven by individuals in London is lower. The regional breakdowns show that the relationship between demographic and socio-economic factors and the three stages of driving is significantly different in London. For example, employment status is associated with smaller increases in the probability of holding a driving licence or having access to a car. This could reflect a variety of factors, including the availability of alternative modes of travel and policies such as the congestion charge, which serve as a disincentive to car usage.

8.6 Year of birth effects are important across the three stages of driving. Being born more recently is associated with lower rates of licence holding, car access and mileage relative to those born earlier than 1955. This could indicate that recent trends in travel behaviour will persist even as people age, if they reflect the impact of belonging to a specific generation.

8.7 Household composition is associated with the greatest differences in car travel behaviour, compared to the base case. Living in a household with more adults is associated with a much higher probability of having access to a car, conditional on licence holding. This may reflect the likelihood that at least one adult will have a car in larger households.

8.8 The relationship between gender and car travel appears to be evolving. Females are less likely to hold a driving licence and drive fewer miles than males. However, they are also more likely to have access to a car, if they hold a licence. The difference between men and women is also much smaller for younger age categories, indicating that a generational shift may be occurring.

8.9 The results reinforce that people are more likely to hold a driving licence and have access to a car if they are older. However, if an individual aged 17-29 can drive and has access to a car, their mileage is similar to the 30-49 and 50-64 age categories. There has also been a much smaller decline in the total miles driven by younger people on average. This indicates that the fall in total distance travelled by younger people seen in recent data reflects lower car access and rates of licence holding.

Recommendations

8.10 Further research into young people's travel behaviour could attempt to quantify generational changes in travel behaviour. It is important to distinguish between effects attributable to an individual's age and those attributable to being born at a given time. If the effects are attributable to the time an individual is born, it implies that recent trends are more likely to persist in future.

8.11 Related to younger people, a methodology to model and consider the impacts of costs of motoring could an important subsequent analysis to this report.

8.12 Further research into the changing relationship between income and car travel is also recommended. The findings in this analysis indicate there has been a weakening in the relationship between income and car travel. It is important to improve understanding of this, since income is widely used as a factor affecting car travel in modelling and appraisal.

8.13 One limitation of this analysis is that it does not extend beyond 2012. The diminished impact of income on the three stages of driving could in part reflect the 2008 recession. Further research should include more recent data to show whether the lesser impact of income is a temporary impact or if it reflects a more persistent trend.

8.14 The results indicate that there may be benefits in differentiating London from other regions in DfT's transport models. Similarly, the recent Road Traffic Forecasts showed that the National Transport Model over forecasts road traffic in London. DfT's modelling and appraisal approach could be improved if it reflected how socio-economic factors appear to have less impact on London compared to other regions.

8.15 The results also highlight the need to monitor trends, including the difference in mileage and licence holding between male and female drivers. If these differences continue to diminish this could have implications for how traffic evolves in future. Changes in the labour market are also likely to have impacts on the decision to drive. Employment is accounted for in the National Trip End Model (NTEM), where it distinguishes between part-time and full-time workers. These trends, and their implications for how much people travel, should continue being monitored.

8.16 While this methodology has shown the effects of different variables, it is unable to explain what is causing them. Further work is needed on this front so that the relationships discovered in this analysis can be explained. This is important for understanding whether they will continue.

8.17 The report indicates there may be some value in including additional segmentations in DfT's modelling and appraisal. This would help reflect people's different car travel

behaviour according to their socio-economic and demographic characteristics. However, this would require careful consideration of the trade-off between the benefits for forecasting future behaviour and the additional resources required to achieve this. As segmentation in our models increases, segments represent an increasingly small number of individuals and have a smaller effect on demand. Both the effect of different factors and the size of the population they apply to need to be considered as DfT looks to develop its modelling and appraisal tools further.

8.18 Caution is required when considering any changes to DfT's modelling and appraisal because different levels of aggregation are used in transport models. This means the trends highlighted in the report cannot simply be applied within the models. The modelling suite has been estimated, calibrated and validated (at its own levels of aggregation) using robust data sources and evidence. This means that provided the composition of the population doesn't significantly change within the forecasting horizon, we would expect them to remain fit for purpose at their existing level of aggregation.

8.19 One way DfT can take these trends into account is through scenario analysis. These can illustrate how car travel demand changes in different states of the world, such as if recent trends in travel behaviour persist. For example, they can show how traffic evolves if recent trends in driving licence acquisition among younger cohorts persist. This is also consistent with the recommendation in Young People's Travel to develop forecasting approaches which account for cohort differences in travel behaviour.

Annex A: Primary regression results

	(1)	(2)	(3)
VARIABLES	Licence holding	Car access	Mileage
Intercept	0.326***	2.005***	114.979***
	(0.034)	(0.080)	(2.212)
Female	-0.843***	0.351***	-53.511***
	(0.014)	(0.028)	(0.964)
London	-1.082***	-2.016***	-77.714***
	(0.030)	(0.071)	(1.881)
Metropolitan	-0.937***	-0.979***	-41.074***
	(0.028)	(0.072)	(1.695)
Large Urban	-0.655***	-0.788***	-34.718***
	(0.025)	(0.067)	(1.408)
Small Urban	-0.414***	-0.525***	-12.606***
	(0.028)	(0.074)	(1.597)
Two Adults	0.664***	1.502***	-18.060***
	(0.016)	(0.028)	(1.328)
Three Adults+	0.327***	1.937***	-18.885***
	(0.019)	(0.039)	(1.565)
Kids	0.161***	0.781***	5.064***
	(0.017)	(0.037)	(1.191)
Age 17-29	-0.353***	-1.204***	31.238***
	(0.024)	(0.050)	(1.812)
Age 30-49	0.631***	-0.655***	35.204***
	(0.023)	(0.046)	(1.551)
Age 50-64	0.699***	-0.038	31.818***
	(0.020)	(0.042)	(1.210)
Employer	0.938***	0.414***	5.026
	(0.060)	(0.104)	(3.208)
Professional	0.956***	0.102	27.420***
	(0.046)	(0.064)	(2.443)
Manager	0.809***	0.478***	49.068***
	(0.030)	(0.055)	(1.880)
Non-manual	0.408***	0.161***	13.782***
	(0.018)	(0.040)	(1.248)
Manual	-0.408***	-0.182***	-8.511***
	(0.019)	(0.041)	(1.378)
Full-time worker	0.466***	0.743***	30.029***
	(0.022)	(0.043)	(1.363)
Part-time worker	0.476***	0.763***	22.481***
	(0.020)	(0.047)	(1.198)
Student	0.676***	-0.248***	31.462***

	(0.055)	(0.090)	(5.213)
Frequent Train	-0.034*	-0.296***	-10.360***
	(0.017)	(0.030)	(1.266)
Quarterly Bus	-0.355***	-0.651***	-10.818***
	(0.014)	(0.028)	(1.005)
Income	0.610***	0.307***	10.145***
	(0.014)	(0.026)	(0.911)
Income squared	-0.046***	-0.021***	0.303**
	(0.002)	(0.003)	(0.125)
Observations	178457	133236	110282
R squared	0.307	0.235	0.159

Standard errors in parenthesis. The mileage regression standard errors are White's HCSE standard errors.
*** p<0.01, ** p<0.05, *p<0.1

Annex B: Year of birth regression results

	(1)	(2)	(3)
VARIABLES	Licence holding	Car access	Mileage
Intercept	0.744***	1.996***	110.120***
	(0.042)	(0.091)	(2.598)
Female	-0.881***	0.350***	-53.144***
	(0.014)	(0.028)	(0.965)
London	-1.088***	-2.017***	-79.531***
	(0.030)	(0.071)	(1.883)
Metropolitan	-0.940***	-0.988***	-42.201***
	(0.028)	(0.072)	(1.692)
Large Urban	-0.651***	-0.793***	-35.586***
	(0.025)	(0.067)	(1.407)
Small Urban	-0.410***	-0.538***	-13.398***
	(0.028)	(0.074)	(1.597)
Two Adults	0.660***	1.515***	-17.931***
	(0.016)	(0.029)	(1.325)
Three Adults+	0.378***	1.946***	-18.725***
	(0.020)	(0.039)	(1.574)
Kids	0.175***	0.801***	5.222***
	(0.017)	(0.037)	(1.202)
Age 17-29	0.911***	-0.265***	42.742***
	(0.052)	(0.101)	(3.614)
Age 30-49	0.933***	-0.163**	37.391***
	(0.038)	(0.078)	(2.456)
Age 50-64	0.698***	0.000	31.325***
	(0.020)	(0.043)	(1.235)
Employer	0.930***	0.403***	3.693
	(0.061)	(0.104)	(3.211)
Professional	0.938***	0.117*	26.931***
	(0.046)	(0.064)	(2.434)
Manager	0.800***	0.488***	48.126***
	(0.030)	(0.055)	(1.877)
Non-manual	0.418***	0.168***	13.644***
	(0.018)	(0.040)	(1.245)
Manual	-0.420***	-0.184***	-9.116***
	(0.019)	(0.041)	(1.376)

Full-time worker	0.517***	0.782***	29.525***
	(0.022)	(0.044)	(1.372)
Part-time worker	0.545***	0.778***	22.525***
	(0.020)	(0.047)	(1.204)
Student	0.709***	-0.161*	30.313***
	(0.056)	(0.090)	(5.215)
Frequent Train	-0.030*	-0.293***	-10.548***
	(0.017)	(0.030)	(1.257)
Quarterly Bus	-0.365***	-0.638***	-9.569***
	(0.014)	(0.029)	(1.006)
Income	0.555***	0.302***	10.756***
	(0.014)	(0.026)	(0.919)
Income squared	-0.040*	-0.021***	0.248**
	(0.002)	(0.003)	(0.125)
1995	-0.617***	-0.306***	7.919***
	(0.046)	(0.090)	(3.386)
1996	-0.627***	-0.220*	23.642***
	(0.044)	(0.088)	(3.407)
1997	-0.606***	-0.136	9.611***
	(0.044)	(0.089)	(3.093)
1998	-0.522***	-0.063	14.151***
	(0.046)	(0.093)	(3.108)
1999	-0.520***	-0.225*	10.458***
	(0.045)	(0.088)	(3.154)
2000	-0.551***	-0.126	10.917***
	(0.044)	(0.086)	(3.039)
2001	-0.559***	-0.119	13.475***
	(0.043)	(0.084)	(3.368)
2002	-0.520***	0.095	8.222***
	(0.034)	(0.069)	(2.348)
2003	-0.485***	0.049	9.919***
	(0.034)	(0.067)	(2.237)
2004	-0.515***	0.056	7.681***
	(0.034)	(0.067)	(2.231)
2005	-0.399***	0.104	5.645***
	(0.033)	(0.066)	(2.121)
2006	-0.308***	0.043	6.343***
	0.033	0.064	2.134
2007	-0.286***	0.107*	5.662***
	(0.033)	(0.065)	(2.134)
2008	-0.283***	-0.043	-2.404
	(0.033)	(0.063)	(2.109)
2009	-0.177***	0.012	-4.704**
	(0.033)	(0.063)	(1.993)

2010	-0.093***	0.035	-0.488
	(0.034)	(0.063)	(2.038)
2011	-0.055	0.048	2.390
	(0.034)	(0.064)	(2.124)
Born 1955-9	-0.118***	-0.291***	0.855
	(0.033)	(0.066)	(2.000)
Born 1960-4	-0.210***	-0.390***	-1.293
	(0.039)	(0.078)	(2.435)
Born 1965-9	-0.236***	-0.463***	-0.648
	(0.041)	(0.081)	(2.633)
Born 1970-4	-0.466***	-0.636***	-7.235***
	(0.042)	(0.083)	(2.761)
Born 1975-9	-0.842***	-1.049***	-12.035***
	(0.047)	(0.089)	(3.060)
Born 1980-4	-1.397***	-1.052***	-13.314***
	(0.053)	(0.104)	(3.774)
Born 1985-9	-1.761***	-1.038***	-14.516***
	(0.058)	(0.118)	(4.308)
Born 1990-4	-2.135***	-0.984***	-24.216***
	(0.070)	(0.163)	(5.338)
Born 1995-9	-3.498***	8.569***	-31.189
	(0.310)	(81.459)	(24.923)
Observations	178457	133236	110282
R squared	0.319	0.239	0.161

Standard errors in parenthesis. The mileage regression standard errors are White's HCSE standard errors.

*** p<0.01, ** p<0.05, *p<0.1

Annex C: Age-area interaction results

	(1)	(2)	(3)
VARIABLES	Licence holding	Car access	Mileage
Intercept	0.173***	1.665***	101.522***
	(0.043)	(0.107)	(2.574)
Female	-0.844***	0.357***	-53.484***
	(0.014)	(0.028)	(0.964)
London	-0.763***	-1.144***	-34.222***
	(0.051)	(0.117)	(2.930)
Metropolitan	-0.738***	-0.706***	-17.893***
	(0.047)	(0.118)	(2.682)
Large Urban	-0.483***	-0.564***	-20.133***
	(0.040)	(0.105)	(2.083)
Small Urban	-0.364***	-0.543***	-9.321***
	(0.045)	(0.116)	(2.437)
Two Adults	0.663***	1.518***	-17.905***
	(0.016)	(0.029)	(1.327)
Three Adults+	0.324***	1.962***	-18.970***
	(0.019)	(0.039)	(1.564)
Kids	0.158***	0.763***	4.799***
	(0.017)	(0.037)	(1.191)
Age 17-29	-0.287***	-0.545***	47.727***
	(0.063)	(0.204)	(4.154)
Age 30-49	1.115***	-0.248	54.864***
	(0.066)	(0.156)	(3.057)
Age 50-64	0.913***	0.498***	44.963***
	(0.062)	(0.178)	(2.906)
Employer	0.936***	0.417***	5.141
	(0.060)	(0.103)	(3.213)
Professional	0.953***	0.104	27.393***
	(0.046)	(0.064)	(2.441)
Manager	0.806***	0.483***	49.035***
	(0.030)	(0.055)	(1.878)
Non-manual	0.407***	0.168***	13.792***
	(0.018)	(0.040)	(1.248)
Manual	-0.410***	-0.186***	-8.748***
	(0.019)	(0.041)	(1.378)
Full-time worker	0.469***	0.727***	29.775***
	(0.022)	(0.043)	(1.363)
Part-time worker	0.472***	0.749***	22.123***
	(0.020)	(0.047)	(1.198)

Student	0.680***	-0.306***	31.499***
	(0.055)	(0.092)	(5.214)
Frequent Train	-0.032*	-0.286***	-10.176***
	(0.017)	(0.030)	(1.266)
Quarterly Bus	-0.354***	-0.656***	-10.721***
	(0.014)	(0.029)	(1.005)
Income	0.610***	0.316***	10.168***
	(0.014)	(0.026)	(0.911)
Income squared	-0.045***	-0.021***	0.306**
	(0.002)	(0.003)	(0.125)
London x Age 17-29	-0.203***	-1.573***	-51.964***
	(0.075)	(0.214)	(5.634)
Metropolitan x Age 17-29	0.001	-0.545**	-29.453***
	(0.074)	(0.221)	(5.200)
Large Urban x Age 17-29	-0.118*	-0.328	-15.950***
	(0.066)	(0.210)	(4.434)
Small Urban x Age 17-29	0.014	0.201	-4.803
	(0.076)	(0.242)	(5.307)
London x Age 30-49	-0.807***	-1.039***	-58.621***
	(0.077)	(0.169)	(3.960)
Metropolitan x Age 30-49	-0.579***	-0.299*	-30.090***
	(0.075)	(0.176)	(3.804)
Large Urban x Age 30-49	-0.486***	-0.290*	-21.529***
	(0.069)	(0.162)	(3.156)
Small Urban x Age 30-49	-0.236***	0.100	-3.821
	(0.078)	(0.183)	(3.717)
London x Age 50-64	-0.316***	-0.791***	-36.575***
	(0.079)	(0.196)	(4.199)
Metropolitan x Age 50-64	-0.362***	-0.599***	-24.075***
	(0.075)	(0.201)	(4.041)
Large Urban x Age 50-64	-0.231***	-0.598***	-14.329***
	(0.067)	(0.186)	(3.263)
Small Urban x Age 50-64	-0.073	-0.252	-5.039
	(0.076)	(0.206)	(3.802)
Observations	178457	133236	110282
R squared	0.308	0.241	0.16

Standard errors in parenthesis. The mileage regression standard errors are White's HCSE standard errors.
*** p<0.01, ** p<0.05, *p<0.1