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A rapid evidence assessment

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Prepared for the UK Department for Transport

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Preface

This report has been produced for the UK Department for Transport. It presents findings of a rapid evidence assessment review of peer-reviewed papers, reports and other 'grey' literature to provide a better understanding of the recent levelling off in total miles driven in Britain. The primary aim of the review was to identify and present findings covering the extent to which technological, social, economic, demographic, political, geographical, and environmental changes have affected car usage and ownership. Evidence is presented on key factors within these areas, and how they affect different demographic groups, when available. A secondary aim was to explore further the drivers of these factors, where such evidence exists. No additional empirical analysis has been undertaken for this work.

While the primary audience for the document is the UK Department for Transport, it may be of wider interest for transport researchers and transport planners who wish to understand better the contribution of different factors to the levelling off in car mileage in the last decade, often referred to as the 'peak car' phenomenon.

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Aims of the review

The aim of this rapid evidence assessment review was to gain a better understanding of the recent levelling off in total miles driven in Britain by reviewing evidence on the factors that may be contributing to this levelling off. Some of the literature in this area uses the term 'peak car' to describe this phenomenon, although this term implies a plateauing or reduction in future traffic levels whereas this report researches the explanation for observed trends and does not seek to comment on forecasts.

The **primary aim** was to identify and present findings covering the extent to which technological, social, economic, demographic, political, geographical, and environmental changes have affected car usage and ownership. By car usage we specifically mean the impacts on car ownership and use (measured as miles driven). Evidence is presented on key factors influencing driving within these areas, and about how they affect different demographic groups, when available. The **secondary aim** was, where evidence exists, to explore further *why* a particular factor is important; for example, if an identified factor is that young adults are delaying licence acquisition and car ownership relative to young adults a decade ago, what the reasons are behind this.

A rapid evidence assessment was employed

A rapid evidence assessment (REA) review aims to be a comprehensive, systematic and critical assessment of the scope and quality of available evidence from the literature. The REA focused on studies that used evidence for the UK or Britain, or international studies that used evidence from the UK or Britain alongside evidence from other countries. As the levelling off in car traffic is considered a relatively recent phenomenon, the search was restricted to material from 1995 onwards. The search was also restricted to passenger demand studies and to studies that were concerned with travel by car.

Two main strands of literature were considered: first, peer-reviewed journals and conference papers, and second, 'grey' literature that typically has not been subject to peer review. A total of 2,802 sources were identified from the literature search. Many of these were not relevant and these were filtered down to a longlist of 58 candidates for review. This longlist of 58 sources was rated by the study team, and from this rating process a short-list of 21 sources for review was agreed with the Department.

Of the 21 sources reviewed, 9 were sources which provided an overview of the peak car issue, and the remaining 12 sources were focused on specific factors or trends impacting upon car mileage.

The literature reviewed provides a good description of the key trends influencing car mileage since the 1990s; however, the size of the impact of these on overall car mileage levels and the drivers impacting these trends are less clear

The reviewed literature provides a good description of the key trends influencing car mileage since the 1990s in the UK. What is clear is that there have been a number of important social, demographic, technical and economic changes in this period, including increased urbanisation and migration, introduction and widespread use of new technologies, increased fuel prices and vehicle use costs, income changes and changes in provision and use of company cars, all of which would be expected to impact car mileage levels. Moreover, we see that different segments of the car travel market are evolving differently; for example, there are different trends in car mileage for men and women. We also see changes in car use patterns from the past; for example, reduced mileage levels for younger drivers – in particular younger males – and increased mileage levels for elderly drivers.

However, the size of the impact of these trends, and evidence on specific drivers impacting upon each trend, is much less clear.

Below we summarise key trends identified from the review, and the evidence on how these have impacted car mileage levels:

- A number of papers acknowledged changes in traditional economic factors, like fuel price increases, changes in vehicle use costs and income growth, but the size of the impact of these effects on car mileage levels was not quantified or discussed.
- Observed reductions in driving levels for young people were well described, but the size of the impact of these trends on car mileage trends more generally, in the short term, but also over the longer term, when young people may be expected to get licences but may have developed different travel behaviour, were less well described. Moreover, key drivers for these changes are not well quantified.
- There was strong agreement that in the last decade there have been substantial population increases in cities; that car ownership and car use are lower in urban areas relative to rural areas; and that young people are more likely to live in urban areas. However, the relative impact of growing population in conurbations and cities on per capita car mileage is relatively small. There was little discussion on reasons or drivers for increasing urbanisation trends.
- There was also high agreement on a number of demographic changes. First, it was observed that car use for women was still increasing, although women were observed to still drive less than men. It was also observed that the elderly drive less than other population groups, although car mileage was also increasing for these groups. Last it was acknowledged that immigration levels increased during the 1990s (Le Vine and Jones (2012) report that during the 1970s and 1980s net migration in the UK never exceeded 60,000/year, but since 1994 it has been above 140,000/year) and that migrants drive less than natives, even after correcting for the fact that they tend to live in urban areas. Again, however, the size of the impacts on overall car mileage was not well quantified.
- There was little information on how employment levels or types of employment, including by industry type or employment type (such as full-time employment, part-time employment or self-employment), may have influenced car mileage.

- While internet technology changed substantially in the period between 1995 and 2010, the effect of information technology on car mileage remains unclear, with some evidence starting to emerge around the impacts of telecommuting, but with much less known about the impacts of e-commerce and social media.
- Detailed information exists on the decline of company car ownership and mileage in the last decade, and how this has particularly impacted total car mileage of men, of those in 'Employer/manager' and 'Professional' employment types, and those living in the South East. These changes are likely to be associated with changes in UK tax policy, but no causality of this relationship is established.
- There is little evidence on how substitutes, in terms of mode shifts or switching to new destinations, for example for international travel, may have impacted car mileage patterns.
- There is little quantitative evidence on how network supply effects, for example through congestion levels, have influenced car mileage patterns.
- There is little evidence on attitudinal changes towards car travel, and how these have influenced car mileage patterns.
- Some authors have suggested that car ownership and usage may be approaching saturation – that is to say, car ownership levels (per household) and the use of those cars have stabilised at some maximum level. However, the evidence for saturation of car usage relies on analysis of aggregate car trends, which do not adequately account for the significant changes in car travel patterns for different segments of the population.

The study has highlighted a number of important gaps in the evidence base

Below we set out, in no particular order, important gaps in the evidence base.

First, there is a need to quantify the size of impact of traditional economic factors, such as changes in fuel prices, travel service levels including congestion, income and GDP changes in explaining changes in car mileage. The review describes a study that has successfully quantified the impact of fuel price and income changes on car mileage in Sweden which provides a methodology that could readily be employed in the UK context. A forthcoming report (Dunkerley et al. (forthcoming)) provides a summary of the latest evidence on fuel price and GDP elasticities on road traffic demand, which could support this analysis. However, we also note the importance of quantifying the impact of other important social and demographic changes, for example changes in company car ownership levels and/or congestion. It is not clear whether the approach adopted in Sweden would easily allow inclusion of these effects. However, the National Transport Model may also provide a means of examining the impact of changes in known factors.

Second, there is a need to quantify the impact of known trends on aggregate changes in car mileage. Headicar (2013) provides good evidence on the size of the impacts of urbanisation on overall mileage levels (which he finds to be surprisingly small), but more work needs to be done to quantify the impacts of other known trends, for example, reductions in driving of young people, increased immigration, etc.

Third, there is a need to understand better the drivers or influencers of some key trends, including understanding why young people are driving less, as well as better understanding travel behaviour of migrants and the elderly. Such analysis should incorporate the role of traditional structural and economic

factors, including income, (student) debt and employment levels, costs, licence-holding, social factors (including age, gender, place of residence, marital/family status, home ownership, nationality, length of time in GB, income, working status, household structures, etc.), changes in attitudes and behaviour towards driving and other transport.

Fourth, there is a need to understand better how international travel may have impacted on travel trends in the UK, as substitution between UK and international destinations may have had an impact on car mileage in the UK. We make this recommendation on the basis that we did not come across any discussion of the potential impacts of international travel on car travel made within the UK.

Fifth, there is a need to understand better the impact of information technology on travel behaviour, including the impact of telecommuting, teleconferencing, e-commerce, and social and business interactions.

Sixth, the impact of changes in working patterns, including telecommuting, the increase in part-time working and self-employment, and other general trends in employment, such as job specialisation, needs to be further researched on different population groups.

Seventh, there is a need to understand better how attitudes to car travel are changing and how these impact car ownership and use.

Moreover, the evidence from our review suggests that models which rely on *aggregate* past trends to predict future car travel levels will not be good enough, given the increasing diversity of the car travel market. It is therefore important that travel demand models incorporate adequate segmentation to ensure that travel behaviour of the different market segments is well represented, and in cases where it is not clear how future trends may play out (for example in the car use of young men), that sensitivity tests are undertaken.

Last, the majority of papers that quantitatively analysed specific trends in car mileage patterns in Britain relied on National Travel Survey data. Thus it is of utmost importance that the Department continues to collect national data on travel trends, so that researchers are able to continue to undertake detailed analysis to understand the changing landscape of car travel. However, it may be that other datasets can also help support our understanding of changes in car mileage patterns, and thus analysis of evidence from other data sources should be encouraged.

Acknowledgements

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Abbreviations

DfT	UK Department for Transport
NTS	National Travel Survey
REA	Rapid Evidence Assessment
SEM	Structural Equation Model
SHC	Strategic Highways Company
TRID	Transportation Research International Documentation
VFRPH	Visiting friends and relatives at private home

1. Introduction and methodology

1.1. Aim of the rapid evidence assessment review

The aim of this literature review was to gain a better understanding of the recent levelling off in total miles driven in Britain by reviewing evidence on the factors that may be contributing to this levelling off. A better understanding of the recent levelling off in miles of travel will give some insight into the longer-term question of whether this is a temporary effect, or a trend that will persist into the future.

The **primary aim** was to identify and present findings covering the extent to which technological, social, economic, demographic, political, geographical and environmental changes have affected car usage and ownership. Evidence is presented on key factors within these areas, and about how they affect different demographic groups, when available. The **secondary aim** was, where evidence exists, to explore further *why* a particular factor is important; for example, if an identified factor is that young adults are delaying licence acquisition relative to young adults a decade ago, what the reasons are behind this reduction.

1.2. Review methodology

A rapid evidence assessment (REA) review aims to be a comprehensive, systematic and critical assessment of the scope and quality of available evidence from literature. REAs follow a similar structure to systematic literature reviews, in that they aim to be replicable and transparent, yet they have the advantage of being less resource intensive. This is achieved by each paper being reviewed by one person only and formally constraining the types of research to be reviewed. Specifically, the relevant literature for this study was restricted in several ways. First, on the guidance of DfT, the focus of the review was studies derived from British or UK evidence, although we also considered international studies which included evidence from Britain or the UK evidence and systematic reviews, where they were judged to be relevant. A key exception was the inclusion in the review of the study by Bastian and Börjesson (2014), a Swedish study that was included because it presented an analysis that in the authors' view was missing from the set of studies reviewed, namely analysis of the extent to which changes in fuel price and GDP could explain trends in car traffic levels. Second, given that the levelling off in car traffic is considered a relatively recent phenomenon, the search was restricted to material published from 1995 onwards to keep the number of potential articles to review to a manageable number. Third, we restricted the papers to those published in English. Last, the review focused on passenger demand studies, and the search was restricted to studies that were concerned with travel by car.

The REA covered two main strands of literature: published, peer-reviewed journals and conference proceedings; and 'grey' literature, which generally contains reports that have not been subject to a peer-review process. The primary database for the search of journal papers and conference proceedings was the Transportation Research International Documentation (TRID) database. The TRID database was searched by a trained librarian, using strategies based on specific combinations of search terms, and the results (abstracts of papers identified through the search strategy) were then screened by the review team to obtain a longlist of relevant papers. The TRID database contains both published articles from peer-reviewed journals, conference proceedings and grey literature, thus it provided much of the literature that was reviewed here. However, this was supplemented by a web search for material, and knowledge of other relevant articles and grey literature by the research team. Full details of the search methodology can be found in the search protocol in Appendix A.

1.3. Selection of papers to review

The search of the TRID database led to a database of 2,802 articles and reports. A longlist of articles for review was identified (58 articles), focusing on evidence on car travel and studies that have been undertaken in the UK (or that included the UK as part of a wider group of countries). Exceptions were considered if the articles described literature reviews, on the basis that they could provide summary evidence from other countries, which was judged to be potentially valuable. We focused on articles covering a wide range of topics, including evidence on car travel trends more generally, as well as more focused articles and reports on car usage trends of young adults, company car ownership, urban densification, and technology.

This longlist was then reviewed by a senior member of the study team, and each article was ranked in terms of relevance. Using this ranking, a proposed shortlist of articles for review was identified and sent to the DfT for their review. Two more articles were then added at their suggestion, and a later stage the Bastian and Börjesson (2014) study was also added (discussed in Section 1.2). The final shortlist comprised 21 different articles and reports for review. These covered a wide range of areas, as shown in Table 1, including general coverage of car mileage trends as well as detailed areas affecting these trends.

The final list included nine journal articles, eight reports and the one conference article identified from the search process, as well as three further grey literature sources identified by the study team and the Department. The 21 different sources reviewed are summarised in Appendix B.

Table 1: Coverage of reviewed articles and reports

Coverage	Count of articles and reports
General	9
Economic factors	1
Land-use	2
Demography and land-use	2
Technology	2
Company cars	1
Substitutes	1
Attitudes	3
Total	21

1.4. The review framework

To structure the reviews, a range of **areas of interest** were set out, describing key areas that could explain the levelling off in miles travelled. For each of these areas of interest we then considered specific **trends** and **drivers** or **influencers** of these trends[1]. For example, 'employment levels and patterns' were considered a general area of interest. Within this area of interest, changes in teleworking levels could be an observed trend, with improved internet technology, a growing service economy, etc., being potential drivers or influencers of this trend. Another example would be 'developments in land-use' as an overall area of interest, with increasing urbanisation a specific trend, and potential drivers or influencers including the location and types of available employment, housing location and preferences, quality and cost of transport, and so on. The resulting list of areas of interest and trends/drivers are summarised in Table 2. This list was based on one provided by the Department, which we added to where we felt there were gaps. It is emphasised that areas of interest or trends are not presented in any order of importance. The list also explicitly allows for 'other' trends and drivers, which were not enumerated prior to the review.

This structure guided the review by focusing the information to be collected from the reviews (on areas of interest, trends and drivers). Specifically, it helped to ensure that the two reviewers reviewed each source on a consistent basis. To provide a further check that the two reviewers were treating the sources consistently, at the outset of the review one of the sources was reviewed by both reviewers. Once this first review was complete the two reviewers sat down together to discuss and contrast their reviews.

In addition to this information, evidence on the impact of the factors or drivers on specific market segment, the type of evidence, for example model evidence or observed data, the date of the evidence and a quality assessment of the evidence was collected in each review.

[1] In general we prefer to use the term 'drivers' of trends. However, in some cases we refer to 'influencers' of specific trends to reduce confusion with drivers of trends about car drivers.

Table 2: List of potential areas of interest, trends and drivers

Area of interest	Trends/Drivers
1 Traditional economic factors	1.1 Fuel prices 1.2 Parking 1.3 Taxation 1.4 Role of income 1.5 Other
2 Reduction in driving levels for young people	2.1 Changes in car costs 2.2 Technology 2.3 Living locations 2.4 Legal restrictions 2.5 Impacts of changes in tertiary education 2.6 Employment levels for young people 2.7 Changing attitudes to driving 2.8 Other
3 Developments in land-use	3.1 Increasing urbanisation 3.2 Travel trends in urban areas 3.3 Other
4 Population structure and demographics	4.1 Population ageing 4.2 Immigration 4.3 Changes in household size / occupancy 4.4 Other
5 Employment levels and patterns	5.1 Teleworking 5.2 Part-time working 5.3 Changing employment characteristics 5.4 Other
6 Technology	6.1 Teleworking 6.2 Online shopping trends 6.3 Social media 6.4 Mobile internet access 6.5 Video-conference, Skype 6.6 Provision of information 6.7 Other
7 Use of company cars	7.1 Taxation policy 7.2 Other
8 Substitutes	8.1 Mode shift 8.2 Shift to new alternatives 8.3 Increasing car occupancy 8.4 Increase in international travel 8.5 Other
9 Supply effects	9.1 Impact of congestion 9.2 Impact of reliability 9.3 Quality of road supply 9.4 Effects of policy, e.g. reallocation of road space 9.5 Other
10 Changing attitudes	10.1 Attitudes to the environment 10.2 Attitudes to cars 10.3 Attitudes to health, e.g. walking, cycling 10.4 Other
11 Market saturation	11.1 Saturation in car ownership 11.2 Saturation in car usage 11.3 Other
12 Other	

2. Key trends and factors influencing car mileage and their drivers

The following sections discuss key trends and factors influencing car mileage levels in Britain since 1995 and drivers and influencers of these, organised by the areas of interest in Table 2.

2.1. Traditional economic factors or prices and incomes

In general, while there was discussion of changes in fuel prices and incomes during the period of interest in specific papers, generally between 1995 and 2010, there was little quantitative evidence on the impact of fuel prices or incomes on changing car travel in Britain in the papers reviewed.

There were significant increases in fuel prices, but also in vehicle efficiency, between 1995 and 2010

A number of studies noted that there had been significant real increases in fuel prices during the period in which miles driven have levelled off. For example, Le Vine and Jones (2012) report a 75 per cent real increase in fuel prices between 1996 and 2001. Newman (2011) notes that fuel prices seem to have consolidated at the upper end of the range observed over the last 50 years, a period over which car mileage grew rapidly. However, Transport for London (2014) reports that while real fuel prices increased by 40 per cent between 2000 and 2012, substantial improvements in vehicle efficiency over the same period meant that mean fuel cost/km was approximately the same in 2000 and 2012.

However, there is little evidence on how changes in fuel prices, and vehicle efficiency, may have influenced car mileage in this period in the British evidence reviewed.

Variation in car mileage across income categories was observed

An interesting observation is that levels of car usage may have changed differentially across income bands in the period of interest. Le Vine and Jones (2012) report analysis of NTS data that shows more or less stable car mileage for the lowest two income bands (£0–10k p.a., £10–20k p.a.) between 1995/7 and 2005/7, but mean travel in the top band falling from 13,000 miles to 10,000 miles over the same period. The authors believe that this pattern is likely be related to observed reductions in company car ownership and usage for high-income groups; the issues around company cars are discussed further in Section 2.7.

Furthermore, Goodwin (2012) suggests that people with higher incomes find it easier to adapt to a less car-dependent lifestyle (but does not suggest reasons why this should be the case) and, expanding on this theme, Dender and Clever (2013) suggest that people with higher incomes find it easier to switch to faster

and more expensive modes such as high-speed rail (considering analysis across a range of countries) and/or to move to expensive downtown locations, which may contribute to the larger changes in car mileage travelled for the higher-income bands.

In contrast, Goodwin (2012) also puts forward the hypothesis that as incomes rise, proportionally more travel is for leisure, and such travel may be more car-oriented than commuting due to greater spatial dispersion of destinations and hence have lower availability of public transport. He also notes that non-commute travel is more price-elastic.

Evidence on the potential for a weakening of GDP effect

This subsection discusses the evidence that emerged from the material reviewed on whether the relationship between GDP growth and growth in car mileage has weakened in recent years.

Goodwin (2012) presents analysis showing how traffic intensity, measured as vehicle-kms/GDP, has evolved between 1980 and 2007 (with intensity expressed as an index with a value of 100 in 1980). He finds that traffic intensity grew rapidly in the 1980s, particularly during the Lawson boom[2], peaking at 116 in 1991. However, it then fell steadily, dropping below the 100 level in 2002 and reaching 92 by 2007. While this analysis is interesting, Goodwin (2012) does not suggest reasons why this apparent 'decoupling' of transport growth from GDP has occurred.

The OECD (2013) report provides detailed econometric evidence on the relationship between GDP and passenger-kms for ten OECD countries, concluding that GDP elasticities on passenger kilometres travelled have shown a decline since 2000. There is some debate over the size of the decline, i.e. whether it is large or small, which depends on the model specification. On the point of the robustness of the estimates the authors note that 'an aggregate model focusing on GDP effects and fuel prices is too crude to capture the diversity and various dynamics underlying aggregate car travel demand and how it changes'.

Further evidence on income elasticities of car demand are contained in the RAND Report 'Road Traffic Demand Elasticities: A Rapid Evidence Assessment', which is being produced in parallel to this report (Dunkerley et al. (forthcoming)). That report looks specifically at the question of whether there is any evidence of a decline in income elasticities over time, identifying two studies which looked at this question, with both finding evidence of decreases in income elasticities over time. However that report also notes that the underlying studies exclude other factors which may have an important impact on the findings, such as the impact of congestion, company car ownership, migration levels, etc. The RAND report also looks at the issue of how income effects are represented in analysis, for example through GDP, household income or expenditure, concluding that 'income elasticities based on household incomes are generally smaller than those obtained for GDP, but there may be other factors involved'.

However, we have seen little evidence in the studies reviewed about what impact traditional economic factors have had on car mileage in the UK

A shortcoming of the UK-based literature is that there is little quantitative evidence on the impact of fuel prices or incomes on changing car travel. The OECD (2013) report concludes that lower (economic)

[2] The Lawson boom is a term used to describe the economic conditions in the UK at the end of the 1980s, and is associated with the policies of the Chancellor of the Exchequer Nigel Lawson.

growth and fuel prices are likely to have contributed to lower car use, across a range of countries, but dismiss these factors as being able to explain all peak car effects. It is not clear what evidence is used to come to this conclusion. In contrast, Bastian and Börjesson (2014) make a strong case that fuel price and GDP changes have had significant impacts on car use (and mostly explain peak car effects in Sweden). They find significant differences in fuel price elasticity between urban and rural areas, hypothesising that residents of urban areas are likely to have better access to other attractive modes and destinations. They also emphasise the importance of income distributions on elasticities. The basis of this analysis is quantitative modelling, using aggregate car-km data, and observed fuel price and income changes. It is noteworthy that they reference similar work carried out in the Netherlands (not reviewed), which they report as reaching similar results. **While conditions in Sweden and The Netherlands may differ from those in the UK, we believe that the principle of quantifying the impacts on car use of known changes in traditional economic factors, like fuel price and income changes, is just as relevant in the UK.**

2.2. Reductions in driving levels for young people

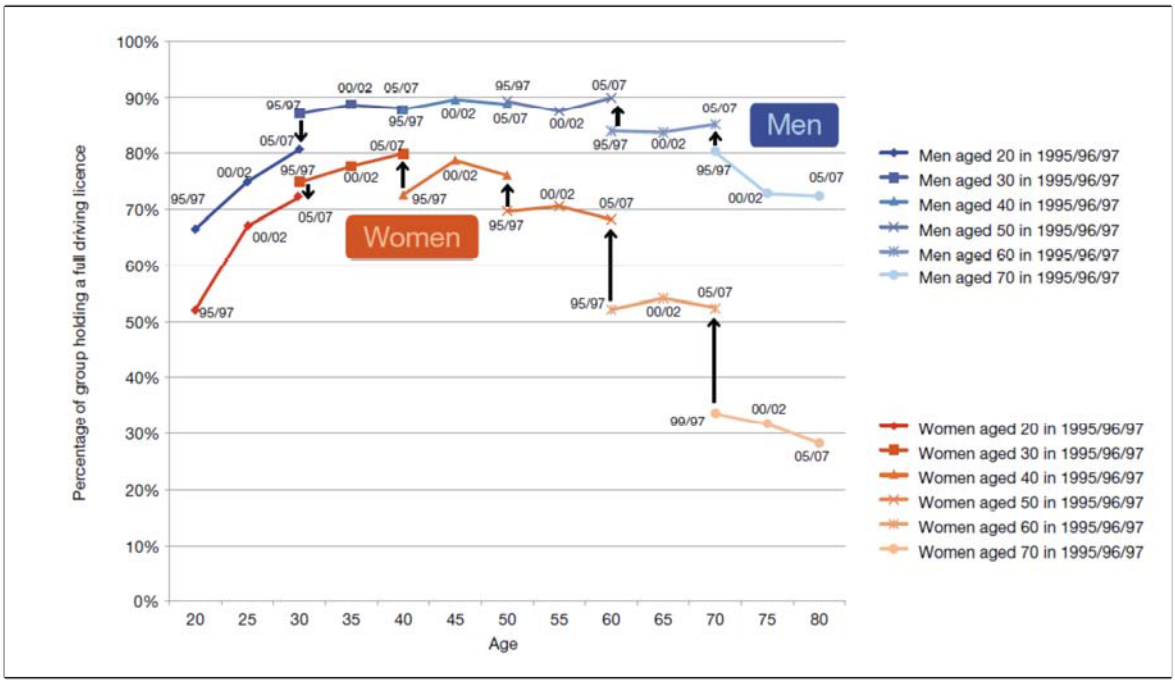
Le Vine and Jones (2012) find, through detailed analysis of NTS data (1995–2007), that both young men and young women (16–19 years) have experienced a decline in annual car driver mileage. However, the largest changes in mobility patterns have taken place among young men: between 1995/7 and 2005/7, car-driving mileage for young men (specifically men in their 20s) fell by nearly 2,000 miles or 30 per cent. They find that around half the average drop in car driving mileage by young men is due to fewer people driving, and half to a reduction in mileage on the part of those who do drive.

There is little discussion in the literature reviewed about the implication of these trends for the future. Stokes (2013) notes from analysis of aggregate NTS data trends that the more experienced a person is in driving (in terms of years of driving), the further the average distance they will drive. So, if young people are delaying driving, this may have implications for future driving trends.

Delayed licence acquisition is part of the explanation of reductions in driving levels for young people

A number of authors have noted that young adults are delaying licence acquisition relative to their predecessors (Le Vine and Jones (2012)). For both males and females, declines in mean licence holding have been observed for the 17–24 and 25–34 age bands, with a particularly noticeable decline for males in the 17–24 age band. For adults aged 35+ licence holding has increased, with the largest increase for females aged 65+. These trends are illustrated in Figure 1, which is taken from Le Vine and Jones (2012) and uses 1995/97, 2000/02 and 2005/07 NTS data. In this figure, the black arrows highlight the change of each group relative to cohorts who were the same age 15 years earlier. For example, the bottom right of the graph shows that just over 30 per cent of women who were aged 70 in 1995/97 had a licence, but by 2005/2007 over 50 per cent of women who were aged 70 had a licence. For younger age groups, the graph shows that licence holding in 2005/2007 was lower than in 1995/97 for both males and females, whereas for older age groups licence holding was higher in 2005/2007 than in 1995/97, particularly for females.

Figure 1: Observed changes in car licence ownership by age and gender (Le Vine and Jones (2012), Figure 3.14)



However, there is little evidence quantifying the drivers that have influenced car driving levels of young people

In general, while detailed high-quality evidence on licence-holding and car driving trends for young people is available in the reviewed studies, there is little evidence about what the key drivers of these trends are, and quantitative evidence on the impact of specific drivers is absent in the material that has been reviewed.

Le Vine and Jones (2012) present the following hypotheses for drivers for the observed changes in annual driving mileage of men in their 20s:

- Decreases in full-time working, with corresponding shifts to part-time working for which annual mileage is less than half that of those in full-time work.
- An increase in those who are single: in 1995/97 22 per cent were married, in 2005/07 this fell to 12 per cent. Young men who are married or who cohabit have, since the mid-1990s, tended to drive more than their single counterparts. Moreover, the gap in mileage that relates to marriage status has grown over time as single young men have seen their private mileage decrease by 30 per cent, compared to a fall of only 10 per cent for married people. By 2005/7, single males in their 20s were on average driving 50 per cent fewer miles annually than their married equivalents.
- An increase in those living with adult(s) aged over 35 (reflecting an increase in those living with parents); young men living with their parents or older adults in the household tend to drive somewhat less than their peers living without an older adult. But both of these groups of young men saw their driving mileage fall by about the same amount – so while this shift in living

arrangements can explain some of the fall in driving mileage, it is only a partial explanation, and a small one at that.

- It is noteworthy that the proportion of men in their 20s who were students did not change between 1995/8 and 2005/7. The authors warn, however, that the NTS sampling protocol excludes students living in halls of residence (but not private off-campus housing), which may influence measurement in changes in student status. They also emphasise that the drop in mileage for young men is measured within the NTS, so such exclusions would not explain the drop in travel. In contrast, Dender and Clever (2013), in analysis of evidence across OECD countries, suggest that increased participation in tertiary education by young people has led to a reduction in their car usage (although they do not present data to confirm this), but hypothesise that this effect may be already played out if tertiary education participation stabilises around its current levels.
- An increase in young people living in London (this is confirmed by the work by Williams and Jin (2013)), where lower per capita car mileage levels are observed (as discussed in more detail in Section 2.3).

Goodwin (2012) presents findings from the analysis of a question that was posed in the 2010 NTS data in order to explore the most important factors for not learning to drive for 17- to 20-year-olds.

The results rank the factors provided to respondents as follows:

1. cost of learning
2. cost of insurance
3. cost of buying car
4. other transport available
5. not interested
6. other general motoring costs
7. safety/nervous about driving.

This ranking suggests that economic factors may be the key drivers for delaying licence acquisition for 17- to 20-year-olds, which is consistent with the 2006 DfT report.

Le Vine and Jones (2012) also note from analysis of 1995–2007 NTS data that high levels of young men and women cite cost as a factor for not having a driving licence, although this varies by household income level. It is interesting to the authors that the responses by males and females in each group are very similar.

We also found little discussion of whether low licence acquisition will continue among the young in the future. It is our view that it is difficult to make such predictions until we better understand the drivers or influencers of these trends, as discussed above.

Moreover, Le Vine and Jones (2012) also note that about a third of the fall in private car mileage among British men in their 20s is in the class of 'visiting friends and relatives at private home' (VFRPH). Correlation analysis by Le Vine and Jones (2012) indicated that:

- Living with an older adult(s) and VFRPH driving mileage is significant and negative (but the same relationship with driving journeys was not significant).
- Being born in Britain was associated with more driving for VFRPH purposes.
- Living in London was associated with less VFRPH (although it is noted this needs to be compared against the generally lower driving levels of Londoners to determine whether it is specific to VFRPH).
- Being a student was associated with higher VFRPH driving mileage (but not journeys).

A limited statistical analysis of the relationships between personal mobility and home delivery of retail goods/services for young men was inconclusive, failing to explain young men's falling shopping travel as being related to Internet shopping; although the growing prevalence of living with older adults seemed to be associated with some drop in miles driven for this purpose.

Le Vine and Jones (2012) also note that further research (and data) are needed to examine whether car mileage has been influenced by mobile telephony and Internet use. More general evidence on linkages between Internet technology and car mileage is discussed further below.

Furthermore, there is little evidence from the studies reviewed of significant changes in the attitudes of younger people towards car ownership and usage

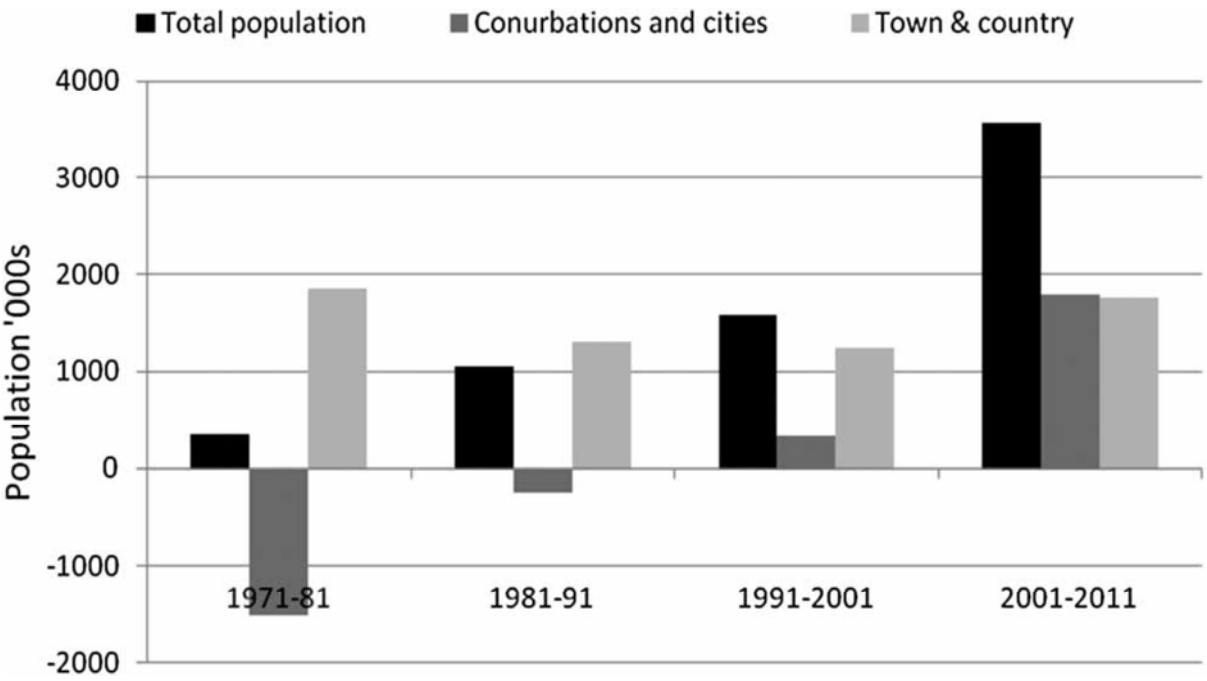
As part of a wider study looking at young people's travel use and experiences, a 2006 DfT report explored the attitudes of young people (aged between 11 and 19) to the car using a sample of 935 schoolchildren who completed a self-completion questionnaire distributed to six schools located across England, and the results from seven focus groups held across England. Their survey revealed some awareness of the environmental impacts of car use, but only a minority expressed this view. The survey found that generally young people were keen to own cars, which were viewed as convenient and fast and that the main drawback to ownership was seen as cost.

2.3. Developments in land-use

The last decade has seen rapid population growth and substantial population increases in cities

Headicar (2013) uses Census data to show that population trends have changed in England in the last four decades. Figure 2 (from Headicar (2013)) shows the *changes* in population in different area types over four 10-year periods. Specifically, the figure shows how the population in urban areas declined over the 1971–81 and 1981–91 periods, but increased over the 1991–2001 and 2001–2011 periods, with a largest increase over the most recent 2001–2011 period.

Figure 2: Changes in England's total population and its distribution, 1971–2011 (Source: Headicar (2013))



Headicar (2013) describes that in 1971, the national population (46.5 million) was almost equally divided between conurbations/cities and urban/rural areas. During the following decade, population increased slightly (by less than 1 per cent), with a growth in the population in town and country areas (a net gain of 1.85 million people) and a decline in population in conurbations and cities (a net loss of 1.51 million). During the 1980s and 1990s, population growth increased, but still with little growth in conurbations and cities. London and some of the principal provincial cities started to see a reverse in this trend, which is attributed to their disproportionate share of service sector employment, and since 2001 the trend of urban revival has become more pronounced (Headicar (2013)). In particular, during the last decade, the increase in England's population has been larger than the sum of the previous three decades altogether, and there has been a substantial change in conurbations and cities, with a nearly equal increase in conurbations and cities and in towns and the country (Headicar (2013)).

Williams and Jin (2013), using population census data for Britain, confirm the trend of substantial population growth in urban areas. However, they also find that the rate of growth is very different by age group. They note that in 1981 most age group proportions were constant across different location types (defined by density), but in 2011 the 25–44 age group were much more strongly concentrated in high-density areas. They also find that while job growth has been strong in low density areas, in many traditionally smaller employment centres job growth has been minimal. They also show that densification of employment has been particularly strong in inner London, and also in centres of other large cities. Further, their analysis shows that in London and large cities, city centres are playing an ever-increasing role in city-wide economic performance. Eight of the ten largest cities have seen private sector jobs become more concentrated in their city centres. Medium- and small-sized cities, on average, have seen an increasing number of private sector jobs being based away from their city centres, with out-of-town employment sites playing a larger role in their economies.

Transport for London (2014) report that 'Over the past 20 years, inner and outer London have seen roughly equal growth in population, despite the fact that outer London is approximately four times the area of inner London'. They also highlight that mean car use in inner London is half that of outer London.

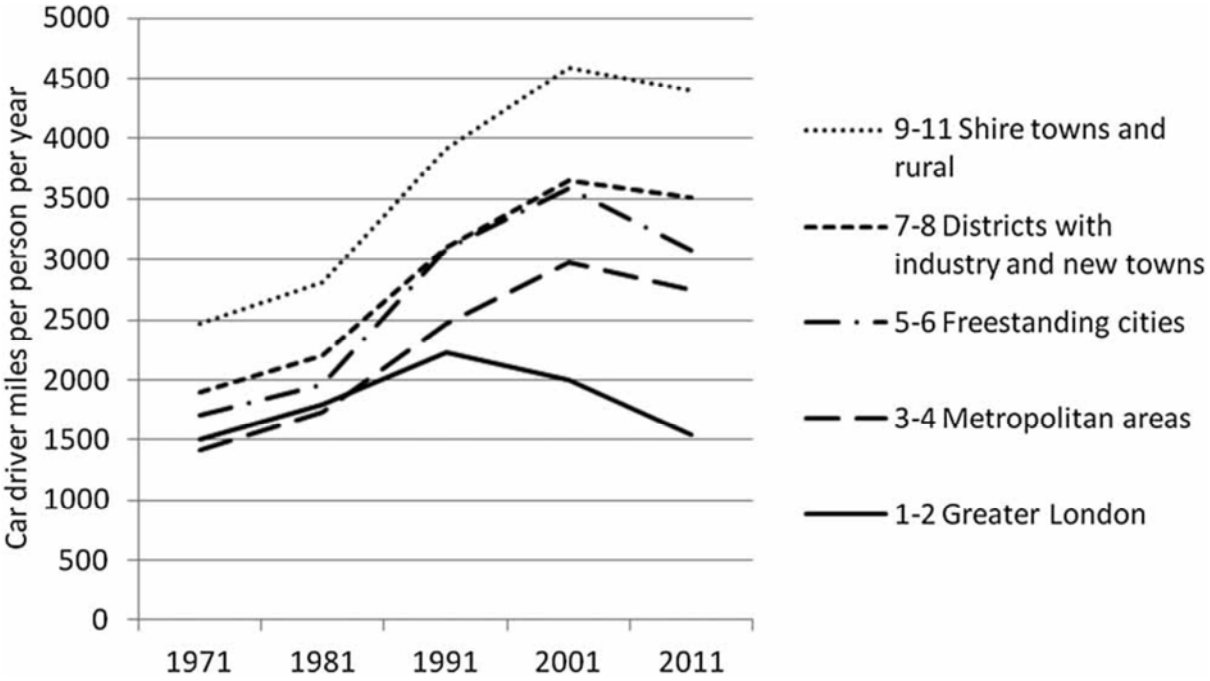
Headicar (2013) provides a number of hypotheses for reasons for the distributional change, which he describes as 'remarkable', given the forces for continued suburbanisation and counterurbanisation. The forces he lists include smaller household sizes leading to more demand for houses, which are more economically provided in less urbanised districts; planning laws which provoke 'leapfrogging' of countryside belts, encouraging development in smaller towns further afield; plus, national policy interventions to address prospective housing shortages that also typically involve expansion of small- and medium-sized towns. However, he notes that counterbalancing this were policies introduced between 1997 and 2008 by the 'New Labour' Government, which saw substantial increase in the development of 'brownfield' sites and the promotion of higher-density housing developments. He notes that much of the population growth in London and other cities is also attributed to 'exceptionally high levels of international immigration'.

In the last decade, there has been a widening gap in per capita car mileage levels between urban and rural areas

Headicar (2013) uses data from the National Travel Survey (for individual years from 2002/03 and for selected years previously back to 1975/76), plus other published literature (ECOTEC Research and Consulting Ltd 1993) to quantify per capita car mileage for different settlement sizes and areas types, consistent with Census definitions (his analysis is shown in Figure 3).

His analysis considers changes in per capita mileage in different area types and changes in the distribution of population between area types. He finds that the **average rate of per capita car driver mileage rose in all area types during the period 1971–2001, with greater growth in less urbanised areas. Since 2001 (and earlier in Greater London) average per capita car driver miles per person have declined in all area types.** The net outcome of these changes is that the difference in average car driver mileage per capita between these area types has widened very considerably over time. In 2011, the average per capita car driver mileage in the least urbanised areas was three times that of Greater London, whereas in 1971 it was only 65 per cent more.

Figure 3: Estimated per capita car driver mileage rates by group area-types, 1971–2011 (Source: Headicar (2013))



Le Vine and Jones (2012) also report declines in private car mileage per resident in Greater London, but not in other areas where they find that private car mileage has increased from 1995/97 to 2005/07 (although it is noteworthy that their analysis stops before the onset of the recession while Headicar's analysis continues through the recession to 2011).

Williams and Jin (2013) confirm strong differences in travel demand across area types, noting that adults living in rural areas compared with those in the densest cities travel twice as far in total and more than three times as far by car as a driver. Moreover, they highlight that settlements below 25,000 people and especially below 3,000 people have particularly high per capita travel demands.

Metz (2013) notes that the percentage of developments that are brownfield (as opposed to greenfield) rose from 60 per cent in 1999 to 80 per cent in 2009, and that brownfield developments would be expected to be associated with lower levels of average car usage, and higher levels of public transport use, than greenfield developments, because there is only limited scope for more car use on congested urban roads. Newman and Kenworthy (2011) also notes that reurbanisation is occurring in the four European cities in their sample (though it is noted that none of these cities is located in the UK).

Aditjandra, Cao and Mulley (2012) used a structural equation model (SEM) with data from Tyne and Wear to explore whether changes in neighbourhood characteristics bring about changes in frequency of driving. They found that, after controlling for self-selection, neighbourhood characteristics do influence travel behaviour. For example, the more people are exposed to access to public transport, the less they drive.

Part of the difference in car driver mileage rates is related to car ownership, where Williams and Jin (2013) find that areas with higher residential density have lower car ownership rates (per adult). Moreover, they find that in 1981–91 residential density did not impact on the growth trend in that car

ownership rate growth rates – these were relatively constant at 25–30 per cent in all areas. However, in 2001–11 car ownership rates in the lowest density areas continued to increase, but rates in the highest density areas were now declining strongly. Thus they observe a clear break from the past, where car ownership trends evolved in the denser areas, hypothesising that land use policies (parking, etc.) have impacted strongly on car ownership patterns.

Moreover, Williams and Jin (2013) look at other influences on car travel in dense cities, particularly supply effects. They find that the costs of owning and using a car in dynamic urban areas have grown significantly, reflecting resident parking charges, destination parking charges, difficulties in finding parking places at workplaces in inner cities, road congestion and improved availability of alternative modes. They also suggest that more stringently applied drink-driving laws may have impacted car travel in urban areas.

Further, they find that both road traffic volumes and speeds have been declining in a range of cities, including in central London, and thus conclude that road capacity reductions are the major cause of reduced road traffic volumes in the most congested areas (a result of switching to alternative modes such as walk, cycle, bus). Away from the main centres, within the conurbations, the pressures of congestion are often much less and therefore they expect car use to continue to grow. Finally, they note that in lower-density areas, which do not have major congestion problems, people simply have fewer options to shift to alternative modes.

Newman and Kenworthy (2011) put forward density arguments explaining why lower levels of car usage would be expected in urban areas, suggesting that density acts as a multiplier on the use of public transport and walking/cycling, as well as reducing the mean journey length. They also suggest that density can result in greater mixing of land uses to meet people's needs nearby, for example the return of small supermarkets to central areas of cities.

Whatever the reasons for the differences in car travel trends between area types, it follows that as the gaps in car mileage grow between area types **the distribution of the population between the area-types will have greater influence in the national rate than it has in the past (Headicar 2013).** This, coupled with the increased urbanisation of the population, would thus lead to trends in reductions in per capita car driver mileage.

However, the overall impact of population distribution on per capita car mileage is thought to be relatively small

Headicar (2013) then goes on to calculate the impacts of the population changes on per capita car driver miles, by calculating the difference between the actual population distribution and the distribution that would have arisen if the distribution of the previous decade had remained unaltered. He shows that **the scale of impact due to population distribution changes is relatively small**. Specifically he calculates that in the last decade spatial redistribution has marginally reduced car driver miles per head by 0.35 per cent (equating to 620 million car miles less). Headicar gives two reasons for why the reduction is smaller than might be expected. The first is that whereas changes in car use apply to the population as a whole, the impact of spatial redistribution only applies to population changes at the margin. The second is the trend in redistribution itself, which has become progressively smaller as population growth has increased.

This perhaps counter-intuitive finding has also been found outside of the UK in the analysis by Bastian and Börjesson (2014), who found through empirical analysis that increases in urbanisation levels are unlikely to have contributed substantially to the observed car kilometre changes observed in Sweden.

2.4. Population structure and demographics

The population is ageing, leading to lower levels of car travel, although older people travel more than their predecessors did

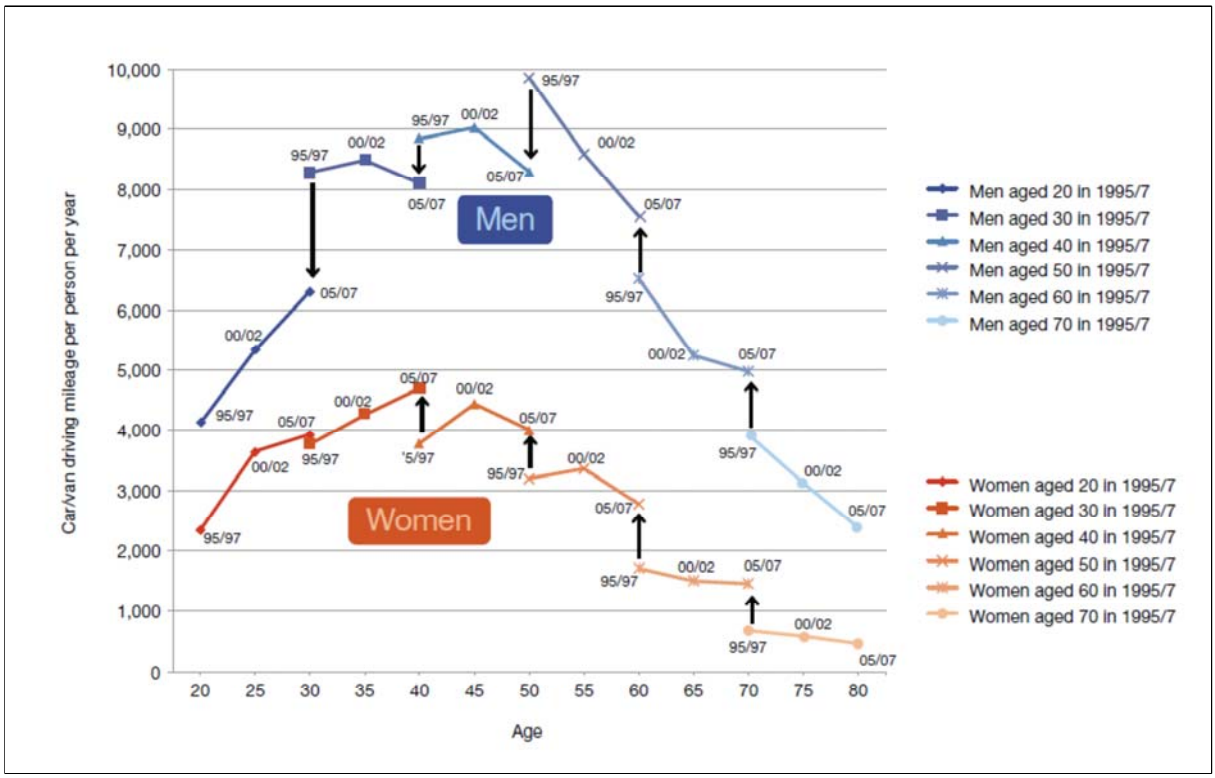
As Garceau, Atkinson-Palombo and Garrick (2014) note, population ageing would be expected to lead to a reduction in mileage as commuting ends with retirement. However, the pattern is complex because licence holding for older people has been increasing, particularly for females. Kuhnimhof, Zumkeller and Chlond (2013) examined changes in car-km by age band using 1996 and 2005 NTS data, and found that the 60+ age group showed the highest growth over this period, whereas car-km declined over the same period for the 20–39 age group. Thus while older people still travel less than people of working age, recently the difference has reduced.

Stokes (2013) notes that it appears that once full car access has been achieved (at least for those currently in older age), there is little propensity to give up car access until one becomes too infirm to drive (though the mileages per driver observed do fall steadily in older age). He highlights the rate at which older people forego their level of access to cars as an important influence on car travel.

Although car mileage levels for women are increasing and levels for men are decreasing, women still drive less than men

Le Vine and Jones (2012) present analysis of 1995/97 and 2005/07 NTS data, showing falls in the average car mileage by men in all age groups up to age 60, with higher percentage falls for younger age groups. By contrast, mileage for females was more or less unchanged for the two youngest age bands (16–19, 20–29) and increased for all age bands for females aged 30 years and above. However, despite these distinct trends for all age groups, men were still observed to drive significantly further than females in the 2005/07 NTS data. This is all illustrated by Figure 4, in which the black arrows illustrate how mileage for individuals of a given age and gender has changed between 1995/97 and 2005/07.

Figure 4: Changes in car driving mileage by age and gender (Source: Le Vine and Jones (2012), Figure 3.6)



Immigration has had a large impact on car mileage

Immigration increased significantly from the 1990s onwards, contributing substantially to the exceptional growth in the population (Headicar (2013)). Headicar (2013) notes that immigration, and national population increase more generally, has been concentrated in conurbations and cities, and especially in London. Le Vine and Jones (2012) confirm this finding, reporting that a larger proportion of London residents were born abroad than non-London residents (38 per cent of Londoners vs 9 per cent of those living elsewhere in Britain, according to the 2010 NTS sample[3]). They also note that **people born outside Britain tend to use cars less**, an effect which is seen most in the 20–39 age group in which migrants are concentrated. The OECD report on 'Long run trends in car use' suggests that increasing proportions of foreign-born inhabitants lead to lower car mobility (controlling for income and predominantly urban location choice), which they attribute partly because of habits, and because visiting friends and relatives in faraway places is less easily done by car (and more by plane or train); the changing geography of friendship and the associated mobility choices take place to a lesser extent outside immigrant communities as well. Dender and Clever (2013) also highlight that increasing proportions of foreign-born inhabitants leads to lower car mobility, all other things being equal.

Le Vine and Jones (2012), again from analysis of NTS data, find that migrants are less likely to have a licence than British-born people, both for men and women, even after accounting for whether the person

[3] The NTS included a question on country of birth from 2010 onwards.

lives in London or not. The biggest difference is among women living in London, where there is a 12 per cent gap in licence holding between people born in Britain and those born abroad.

In the analysis of car mileage trends in Sweden, Bastian and Börjesson (2014) highlight the importance of immigration levels for vehicle kilometres travelled (VKT) per adult trends in Sweden, because of its contribution to urban population growth, income inequality and driving licence gap, noting that 'Immigrants' lower licence holding levels, lower average income and higher concentration in urban areas contribute to the stronger decline of VKT per adult in urban areas'. They attribute Sweden's remaining gender gap in licence holding to the substantial gender gap among foreign-born populations and due to the oldest generation. They hypothesise that the gender gap among seniors will continue to shrink as today's younger retirees replace the oldest generation. However, the gender gap among foreign-born residents as well as the gap between Swedish and foreign-born residents may well remain, especially as immigration numbers are expected to remain high over the coming years (Statistics Sweden (2014)). While this is Swedish, not UK, evidence, it is consistent with the differences between natives and migrants identified in the UK evidence discussed earlier.

However, there is little evidence in the papers that we have reviewed quantifying why migrants drive less, and to what extent this is a function of their current situation, locations of family and friends, travel cost, income, age, culture, attitudes, etc., and how these patterns may develop over time. We believe that this is an area where more research is needed.

2.5. Employment levels and patterns

In the papers reviewed, we found little discussion on how employment levels or types of employment, including by industry type or employment type (such as full-time employment, part-time employment or self-employment), have influenced car mileage. The one exception to this is the observation by Headicar (2013) that service employment levels have driven urbanisation trends, which have had subsequent impacts on car travel trends.

2.6. Information technology

Internet technology has improved substantially in the period between 1995 and 2010, with nearly 75 per cent of households having an Internet connection, which makes it much simpler to both obtain travel information and carry out social interactions and commercial transactions online (Le Vine and Jones (2012)).

There is some evidence that telecommuting reduces car usage, but the impact of e-commerce and social media on travel is unclear

Mans et al. (2012) look at evidence from literature on ICT use, specifically telecommuting, e-commerce and use of social media, on travel behaviour. It is noteworthy that much of the evidence in their review is US-based. They report that although many early studies found a positive correlation between telecommuting and travel, more recent studies have found that telecommuting tends to either reduce work-related travel or modify the nature of work-related travel, for example in terms of time of travel, which can impact congestion levels. Interestingly, they find that telecommuting can lead to increased productivity, and may be an important employment incentive.

In terms of British evidence, the work by White et al. (2007) looks at trends in teleworking and teleconferencing, and the impact that these have on travel. They provide an indication of the levels of teleworkers, from Labour Force Survey (LFS) reports, finding that 2.6 per cent of workers worked mainly from home, 7.5 per cent worked from home at least once a week and 23 per cent sometimes worked from home. The reports also indicate that for those who work at home, 80 per cent used computers and telephones in their work. They find that NTS provides a broadly similar picture, indicating that about 2 per cent of all working days are worked at home by those doing so at least once a week, in addition to around 3 per cent who always work at home. For Greater London and the South East the proportions observed in the NTS data were slightly higher, with 7.5 per cent of respondents having worked at least one day at home in the previous week, with a similar average of 2.3 days each, implying about 3.5 per cent of all days being worked in this form. In 2002–2004, a further 6.3 per cent of respondents indicated working at home less than once a week, but at least once a year.

From interviews with organisations, they found that those in middle to senior management positions and the 'nomadic workforce' were more likely to telework. The LFS indicates that about 12 to 14 per cent of those classified as 'managers and senior officials', 'professional occupations', 'associate professional and technical', 'administrative and secretarial', and 'skilled trade' had engaged in teleworking. The first three of these categories represented 68 per cent of all teleworkers in 2002 (Cairns and Harmer (2004)). Conversely, in 'personal services', 'sales and customer services' and 'process, plant and machine operatives' only about 8 per cent teleworked, representing in aggregate only 7 per cent of all teleworkers. The NTS suggests a similar pattern by employment group, and also a strong association between teleworking and income. Of those who had worked at home one day or more in the previous week, 18 per cent had an income of £40,000 or more, and 46 per cent between £20,000 and £39,999: comparable percentages for those 'usually working at another location' were 6 per cent and 31 per cent respectively.

The White et al. (2007) study provides a wide range of estimates on the impacts (reductions) in weekly travel (mostly based on US literature). These suggest reductions in car mileage of between 48 per cent and 77 per cent on teleworking days, with a reduction of between 9 per cent and 11 per cent over the week as a whole when traditional working days are also included (based on work by Balepur et al. (1998); Jensen et al. (2003)). There may be some offsetting effects when additional journeys undertaken from home on teleworking days are included. However, they find these tend to be relatively short, so that a substantial net reduction is still observed.

White et al. (2007), also look to see the impact on trip frequency for those who work at home, based on analysis of NTS data. They find individuals who work from home make fewer commuting trips across all modes (as might be expected), but more business trips. However, when looking at average distances travelled, the trends are less clear. The authors observed that all telecommuting subgroups exceed the average reported by working-age males in 2004 (around 11,000 miles, or 17,700 km). Their expectation is that as teleworking increases average distances will fall. However, this only becomes evident at the highest frequency, of three or more times a week, which displays a drop of 31 per cent from the figure for the 'once or twice a week' category. This is associated not only with a reduction in commuting, but also in 'business' travel and some other purposes. Their conclusion is that there is not a simple relationship between commuting and business travel and telecommuting, probably due to an association between working at home and greater average distances between home and work, which in turn is related to income and occupation. They also expect correlation between income and greater travel distances.

The impacts of e-commerce on travel are less clear. Mans et al. (2012) cite that most studies on the topic have found mixed results: in some cases, online purchases replaced a shopping trip and, thus, reduced shopping-related travel, and in other cases, e-commerce resulted in new shopping trips, for example because people may have made special trips to a shop for that specific item. Moreover, they note that the delivery of online merchandise may increase the number of trips for mail and package delivery. They note that it is also likely that the purchase of different types of goods may result in different effects, i.e. if you purchase merchandise, such as music or e-books that replace the purchase of a physical equivalent, reductions on road traffic will be most pronounced. If a physical item is purchased, then the trip to purchase this item may be replaced by the delivery of the item. Thus, Mans et al. (2012) suggest that the final effects of online buying on travel may depend on what is purchased and how likely the consumer is to use online shopping as a substitute for shopping in a physical store. We would add to this that the issue of how much can be bought on a trip to a shopping centre versus the extent to which delivery companies can group deliveries will influence the impacts on travel, and furthermore some e-shopping is 'click-and-collect' and as such results in a shopping trip just like traditional shopping trips.

Similarly, they find that the impacts of social media sites and the expansion in social networking on travel behaviour are complex and not yet understood. For example, in some cases, online interactions might replace social interactions; alternatively, by widening an individual's social network, this technology may be complementary with travel because social networking increases the ease of connecting with others. They cite work by Contrino and McGuckin (2006) using the US 2001 National Household Travel Survey to provide some preliminary evidence that Internet users may be reducing their time travelling for social and recreational reasons. They find that, for all age groups, Internet users travelled fewer minutes for social and recreational trips than the average for that age group. This effect appears to be somewhat more pronounced for the younger age groups than it is for the older ones, although it is not clear if any of the differences are statistically significant. It is noteworthy that Mans et al. (2012) focus specifically on social media sites, and do not discuss other aspects of technology and communication/social interaction that are occurring, for example through e-mail, text, Skype, online gaming, etc.

2.7. Use of company cars

Le Vine and Jones (2012) look at the trends in car use over time for different demographic and geographical groups in Britain and find that **a major contributory factor to the observed decline in car use by males between 30 and 60 years of age has been a sharp reduction in average company car[4] mileage per person**. The conclude that while companies have never accounted for more than a tenth of Britain's car stock, they have contributed disproportionately to overall traffic levels; and changes in fiscal policy affecting company cars have been associated with reductions in company-car use that have had a major impact on overall car traffic levels, although no formal causal relationship is developed.

Company car ownership and mileage has declined significantly between 1995/97 and 2008/2010

Le Vine et al. (2013) provide a thorough history of changes in company car taxation policy in Britain, which has impacted: (i) incentives for providing a company car, (ii) incentives for providing free fuel, and (iii) incentives for increased travel with a company car. As noted above, they associate these changes with substantial changes in ownership and use of company cars. Moreover, no formal causation relationship between these changes and changes in ownership and company car use are established, and no further analysis of other possible changes in organisation behaviour that may have impacted company car policy are discussed.

In the way of background, Le Vine et al. (2013) report that in the 1995/96 tax year, approximately 1,650,000 UK tax payers, on their tax return, reported having a company car; by the 2009/10 tax year, this had fallen to 970,000 – a drop of 41 per cent. Of the company car drivers registered with the tax authorities in 1995/96, about half (48 per cent or 800,000 taxpayers) also reported receiving free fuel for their personal use. But by 2009/10, this had dropped to 28 per cent (270,000 taxpayers). The number of company car drivers not receiving free fuel fell by only 16 per cent, while the number of company car owners receiving free fuel for personal use dropped by 70 per cent.

From analysis of NTS data, Le Vine et al. (2013) find that company car mileage per capita fell by 37 per cent from 1995/97 to 2005/07. They did not find consequent growth in the use of non-household cars, the category which includes employers' fleets of pool cars, concluding that there is no evidence of a large-scale shift from company cars that employees keep for their personal use to pool cars that they can use on a one-off basis for specific business travel journeys. They find that company car ownership fell 31 per cent on a per capita basis between 1995/97 and 2008/10, while the mileage per company car declined by 25 per cent. So 55 per cent of the reduction in (aggregate) company car mileage is associated with lower car ownership and 45 per cent with less intensive use of each remaining company car. Over the same period, personal car ownership increased by 18 per cent, while average mileage fell about 11 per cent on a per car basis. Although it is noted that company car drivers still drive over twice as much (2.5 times) as people driving their own cars.

[4] A 'company car' refers to a car that is owned by an employer (or a specialist third-party firm that leases the car to the employer) and made available to an employee on a continuous basis for their business and private use, as part of their remuneration package.

Changes in company car ownership have had a significant impact on car mileage for men

Le Vine et al. (2013) find substantial differences in company car ownership and use changes, and car use changes more generally, between men and women, specifically finding:

- Although women have much lower levels of company car ownership than men, ownership levels among women have remained much more stable in the last decade; further, women aged 30 and over have **increased** their average total car use, by around 800 miles per annum, attributed almost entirely due to an increase in personal car use.
- Conversely, men aged between 20 and 60 have reduced their total car use and for those aged between 30 and 60, the vast majority of that reduction has been in company car mileage; men in their 20s have also substantially reduced their mileage in non-household cars.
- Moreover, the impact on reductions in company car use are higher for high income households (and if company car mileage changes are not taken into account, then it appears that the sharpest declines in driving occur for the households with highest incomes, which may seem counter-intuitive, as discussed above);
- This is further illustrated when looking at company car changes across different employment types, whereby it is observed that the highest ownership levels are among 'Employer/manager' and 'Professional' employment types (in the mid-1990s, more than one in five of the former and one in eight of the latter had a company car); but between 1995/97 and 2008/10 the rate of company car ownership fell most sharply among these classes.
- There are also geographical differences; in 1995/97, the prevalence of company cars was 32 per cent greater in the South East than the rest of Britain; but by 2008/10 this had reversed and it was 6 per cent lower in the South East than elsewhere (Le Vine and Jones conclude that the drop in company car activity by Londoners was sharp enough to be a major contributor to London's falling traffic levels in recent decades).
- Moreover, the highest annual car mileages – and the largest reductions in car mileage, and most of this due to less company car mileage – are found among adults living outside London who visited it on two or more occasions in their NTS diary week for commuting/business-related purposes. It is noteworthy that substantial reductions in car mileage for this group occurred between 1995/97 and 2000/02, before the introduction of congestion charging in Central London.

There has been substitution between company car mileage and personal car mileage, but this does not completely counterbalance company car mileage losses

Le Vine et al. (2013) investigate two potential substitution effects of the company car mileage: (i) between company and private car travel, and (ii) between company car and rail mileage. Because they rely on analysis of NTS data, a repeat cross-section survey and not a panel survey, only group average results can be reported (with resulting limitations in establishing causality). They find that there is little evidence of a net substitution effect between company and private car mileage for employed men, in aggregate. Professionals have seen reductions in both company car and personal car mileage; however, in contrast, there is strong and consistent evidence of substitution between company and private car mileage among the 'employer/manager' group – while company car mileage fell on average by 3,222 miles, private car

mileage increased by 821 miles – a 4:1 substitution. The picture is very different for women, where both company car and private car mileage have been increasing for most groups. Again, though, the major exception has been among the 'Professional' group, where company car mileage has dropped significantly – suggesting to the authors that the nature of the class described as 'Professional' has probably changed substantially in nature in recent decades.

There is also some evidence of a shift from company car to rail travel. Le Vine et al. (2013) report a strong negative relationship for men's business mileage (r^2 = 0.89) and by rail (women see a small growth in business mileage both in company cars and by rail). For men, this relationship indicates that for each mile of reduction in company car user for business travel roughly a quarter-mile seems to have shown up as increased rail use. There is a somewhat weaker relationship for men between company car and rail mileage for travel for visiting friends and relatives VFR.

What future effects will company car ownership have on overall car mileage levels?

Le Vine et al. (2013) note that the decline in company car ownership and use cannot continue indefinitely (in 2008/10, levels of company car ownership had already dropped by over 40 per cent since the mid-1990s). This raises the as yet unanswered question of whether, once the trend of decreasing company car mileage has run its course, average mileage will start to rise again.

2.8. Substitutes

In the review we considered a number of different substitutes that would impact car mileage: mode shifts to public transport or new alternatives, increasing car occupancy as well as substitution of trips to different destinations, i.e. increases in international travel.

We came across very little discussion about the impact of substitutes influencing car mileage levels at an aggregate level. One exception is the observation by Le Vine et al. (2013), about substitution between company car and rail travel for business travel for men. Second, Dender and Clever (2013) note that urbanisation shortens travel distances which makes non-car modes more attractive, and public transport availability tends to be higher in urban areas. This links to the evidence on increasing urbanisation discussed in Section 2.3.

Further, we did not come across any discussion of the impact of international travel on travel made within the UK, particularly for leisure markets. Much of the analysis reported in the papers reviewed is based on National Travel Survey data, which does not collect information on international travel, and thus in the authors' views this remains an under-researched area.

2.9. Supply effects

Increasing congestion may be contributing to the levelling off of miles travelled, but there is no direct evidence of the size of this effect

Le Vine and Jones (2012) describe how the provision of additional motorway and dual carriageway mileage levelled off around 2000, and that there is evidence that average speeds are falling due to increased traffic volumes. It could be hypothesised that worsening of the highway supply is playing a role

in the levelling off of car mileage, but Le Vine and Jones (2012) do not explicitly suggest this. However, they do note that while the prices of new and second-hand cars have fallen, most other costs associated with car ownership and use have risen sharply (alongside marked increases in bus and rail fares). Williams and Jin (2013) echo this finding, noting that the cost of owning and using a car in dynamic urban areas has grown significantly, reflecting resident parking charges, destination parking charges, difficulties in finding parking places at workplaces in inner cities, road congestion and improved availability of alternative modes. They suggest that evidence (not provided) supports the hypothesis that in dense dynamic cities road capacity reductions are the major cause of reduced road traffic volumes in the most congested areas (a result of switching to alternative modes such as walk, cycle, bus). Away from the main centres, within the conurbations, the pressures of congestion are often much less and therefore they expect car use to continue to grow. Lastly, they note that in lower density areas, that do not have major congestion problems, people simply have fewer options to shift to alternative modes.

2.10. Attitudes to the car

There is little evidence from the studies reviewed of significant attitudinal changes towards car ownership and usage

The Lucas and Jones (2009) work explored the changing nature of car ownership and usage within British society. In their key findings section they note that the car and traffic component of total travel has grown at a slower rate in recent years, and since 2002 has stabilised on a per adult basis. They suggest a number of factors that may have contributed to this – completion of the major new road capacity programme and associated dispersion of land uses, the changing socio-demographic profile of the car driving population or the growth in traffic congestion – but put forward these suggestions alongside a clear statement that the evidence is unclear.

One section of the Lucas and Jones work examined public attitudes towards the car, drawing on three surveys: the annual Lex/RAC Report on Motoring survey, the British Social Attitudes Survey and a study for DEFRA undertaken by 2007 by the British Market Research Board (BMRB). Their analysis of these sources suggests that respondent's attitudes to driving have remained fairly constant over the past 20 years, with 80 to 90 per cent of respondents still saying that they would find it difficult to adjust their lifestyles to living without a car. They noted that in the last three to four years (before their 2009 study) there appeared to be a slight increase in the number of drivers who said that they would be prepared to use their cars less if public transport were better; however, it was unclear to Lucas and Jones as to whether this was because drivers though public transport was getting worse or whether attitudes towards public transport were better.

Lyons et al. (2008) also explored attitudes to the car. He and his co-authors report that many drivers see aspects of their car usage as necessary, for example for carrying large objects or small children, because of limited PT provision, and so on. Moreover, older drivers felt strongly that driving enhanced their independence. They also noted that many women have complex travel patterns impacted by both work and family responsibilities, and are thus particularly attracted to the flexibility and convenience of car use.

While desire for cars is widespread among children and young people, they also found stronger negative views among young people.

As discussed in Section 2.2, there is little evidence from the studies reviewed of significant changes in the attitudes of young people towards car ownership and usage.

2.11. Market saturation

Some authors have suggested that car ownership and/or usage may be approaching saturation levels

Both Garceau, Atkinson-Palombo and Garrick (2014) and Newman and Kenworthy (2011) present the 'Marchetti Wall' hypothesis, namely that with increasing congestion vehicle speeds reduce, and consequently the distance that can be travelled within a mean 1 hour travel budget reduces as well. However, Garceau notes that in England congestion levels have been relatively constant recently while vehicle travel has decreased.

Metz (2013) also suggests saturation effects as a factor in the levelling off in car mileage, citing examples of saturation in ownership in consumer products such as telephones, computers and Internet connections. The strength of the relationship between saturation in ownership and saturation in car mileage is not discussed in Metz's paper

Goodwin (2012) highlights that aggregate forecasts incorporating a saturation effect from the early 1970s predict 2010 car ownership levels (cars/people) and 2010 car traffic levels remarkably well. He also expands on what he sees as two schools of thought about saturation:

- That there is a strong elasticity of distance to income that does not diminish over time, but total time spent travelling is stable. As incomes increase, individuals transfer to faster modes, but once transfers are complete traffic stabilises.
- The number of destinations that can be reached within a given distance rises, on average, with the square of distance. Since total travel time is stable, there is increasing resistance to travelling further, and the positive income elasticity declines in importance relative to the travel time constraint. So income elasticity is expected to decline.

He states that determining which, if any, of these two hypotheses applies is in principle empirically testable.

In summary, while a number of the sources reviewed suggested the car ownership and/or usage may be approaching saturation, the evidence presented to support this hypothesis is limited. Specifically, Goodwin (2012) presented a chart showing changes in car traffic levels between 1970 and 2010, which shows aggregate car traffic levels dropping slightly after 2007, but this dropping off could plausibly be attributed to the economic downturn or changes in specific segments of the population rather than a long-term saturation effect.

3. Conclusions and recommendations

The reviewed literature provides a good description of the key trends influencing car mileage trends since the 1990s in Britain. What is clear is that there have been a number of important social, demographic, technical and economic changes in this period, including increased urbanisation and migration, introduction and widespread use of new technologies, increased fuel prices and vehicle use costs, income changes and changes in provision and use of company cars, all of which would be expected to impact car mileage levels. Moreover, we see that different segments of the car travel market are evolving differently, for example car travel for women is increasing while for men car travel is not increasing. We also see changes in car use patterns from the past, namely for young people, particularly young men, who are driving significantly less than in past, and elderly people who are driving more.

However in general, the **size** of the impact of these changes, and evidence on the specific drivers or influencers of these trends, is much less clear. In Table 3 we attempt to assess the strength of evidence on key trends on car mileage patterns, the strength of evidence on their likely impact on car mileage and what is known about drivers or influencers of these trends.

Below, we summarise the key trends identified from the review, and the evidence on how these have impacted car mileage levels.

- A number of papers acknowledged changes in traditional economic factors, like fuel price increases, changes in vehicle use costs and income growth, but the size of the impact of these effects on car mileage levels was not quantified or discussed.
- Observed reductions in driving levels for young people were well described, but the size of the impact of these trends on car mileage trends more generally, both in the short term, but as well over the longer term, when young people may be expected to get licences but may have developed different travel behaviour, were less well described.
- There was strong agreement that in the last decade there have been substantial population increases in cities; that car ownership and car use are lower in urban areas relative to rural areas; and that young people are more likely to live in urban areas. However, the relative impact of a growing population in conurbations and cities on per capita car mileage is relatively small. There was little discussion on reasons or drivers for increasing urbanisation trends.
- There was also high agreement on a number of demographic changes. First, it was observed that car use for women was still increasing, although women were observed still to drive less than men. It was also observed that the elderly drive less than other population groups, although car mileage was also increasing for these groups. Last, it was acknowledged that immigration levels increased during the 1990s (Le Vine and Jones (2012) report that during the 1970s and 1980s net

migration in the UK never exceeded 60,000/year, but since 1994 it has been above 140,000/year), and that migrants drive less than natives, even after correcting for the fact that they tend to live in urban areas. Again, however, the size of the impacts on overall car mileage was not well quantified.

- There was little information on how employment levels or types of employment, including by industry type or employment type, such as full-time employment, part-time employment or self-employment, may have influenced car mileage.
- While Internet technology changed substantially in the period between 1995 and 2010, little evidence is available on how information technology affects car mileage, although some evidence is starting to emerge around the impacts of telecommuting, but much less is known about the impacts of e-commerce and social media.
- Detailed information exists on the decline of company car ownership and mileage in the last decade, and how this has particularly impacted the total car mileage of men, of those in 'Employer/manager' and 'Professional' employment types, and those living in the South East. These changes are likely to be associated with changes in UK tax policy, but no causality of this relationship is established.
- There is little evidence on how substitutes, in terms of mode shifts or switching to new destinations, for example for international travel, have impacted national car mileage patterns.
- There is little quantitative evidence on how network supply effects, for example through congestion levels, have influenced car mileage patterns.
- There is little evidence on attitudinal changes towards car travel, and how these have influenced car mileage patterns.
- There is suggestion that car ownership and usage may be approaching saturation – that is to say car ownership levels (per household) and the use of those cars have stabilised at some maximum level. However, the evidence for saturation of car usage relies on analysis of aggregate car trends, which do not adequately account for the significant changes in car travel patterns for different segments of the population.

Below, we set out, in no particular order, important gaps in the evidence base that should be addressed.

1. Quantify the size of the different factors and trends in explaining the overall changes in car mileage.

   One area of analysis would be to quantify the impact of travel costs, including fuel price, and income changes on car mileage. One approach to do this would be to undertake similar analysis to that undertaken by Bastian and Börjesson (2014) to quantify the impact of fuel price and income changes on car mileage in Sweden. Their analysis considers the impact of fuel price and income changes, and examines the impact for different groups of municipalities (that can be categorised as urban or non-urban). A forthcoming report (Dunkerley et al. (forthcoming)) provides a summary of the latest evidence on fuel price and GDP elasticities on road traffic demand, which could support this analysis. In our view it would be interesting to examine whether such analysis could be extended to quantify the impacts of congestion. This will depend on the level of detail of car kilometre data that is available, as well as the availability of information on congestion levels nationally (ideally with some geographical disaggregation).

Of equal importance is also to quantify the impact of other social and demographic changes, for example changes in company car ownership levels. It is not clear whether the Bastian and Börjesson (2014) approach would easily allow inclusion of these effects. However, the National Transport Model may also provide a means of examining the impact of changes in known factors.

2. Quantify the impact of known trends on aggregate changes in car mileage. Headicar (2013) provides good evidence on the size of the impacts or urbanisation on overall mileage levels (which he finds to be surprisingly small), but more work needs to be done to quantify the impacts of other known trends, for example, reductions in the driving of young people, increased immigration, etc.
3. Improve understanding of the key drivers or influencers on driving levels, including understanding what has caused young people to drive less, as well as what has influenced the travel behaviour of migrants and the elderly. Such analysis should incorporate the role of traditional structural and economic factors, including income, (student) debt and employment levels, costs, licence-holding, social factors (including age, gender, place of residence, marital/family status, home ownership, nationality, length of time in GB, income, working status, household structures, etc.), changes in attitudes and behaviour towards driving and other transport. We note that identifying causation may be challenging because many influences are highly correlated, for example income, location, age, etc.; however, this remains an area where further research is necessary, and where longitudinal evidence may be necessary to track changes over time and identify drivers of change.
4. In our review we did not come across any discussion of the impact of international travel on car travel made within the UK, and therefore conclude that there is a need to understand how international travel may have impacted travel trends in the UK, particularly in the leisure market.
5. There is a need to understand better the impact of information technology on travel behaviour, including the impact of telecommuting, teleconferencing, e-commerce, and social and business interactions.
6. The impact of changes in working patterns, including telecommuting, the increase in part-time working and self-employment, and other general trends in employment, such as job specialisation, needs to be researched on different population groups.
7. There is a need to understand better how attitudes to car travel are changing and how these impact car ownership and use.

Moreover, the evidence from our review suggests that models that rely on **aggregate** past trends to predict future car travel levels will not be good enough, given the increasing diversity of the car travel market. It is therefore important travel demand models incorporate adequate segmentation to ensure that travel behaviour of the different market segments is well represented, and in cases where it is not clear how future trends may play out, for example in the car use of young men, that sensitivity tests are undertaken.

Last, the majority of papers that quantitatively analysed specific trends in car mileage patterns in Britain relied on National Travel Survey data. Thus it is of the utmost importance that the Department continues to collect national data on travel trends, so that researchers are able to continue to undertake detailed

analysis to understand the changing landscape of car travel. However, it may be that other datasets can also help support our understanding of changes in car mileage patterns, and thus analysis of evidence from other data sources should be encouraged.

Table 3: Importance of trends on overall car traffic levels, and what is known about influencing drivers of these trends

Trend	Strength of evidence on influence on car mileage patterns in Britain	Likely impacts on car mileage	What is known about the influencing drivers of these trends
Traditional economic factors – fuel, GDP	Mixed – Size of the impact of these factors is not well quantified in reviewed papers for GB/UK. Bastian and Börjesson (2014) make a strong case that fuel price and GDP changes have had significant impacts on car use (and mostly explain peak car effects in Sweden).	Size of impact is unclear – Bastian and Börjesson (2014) make a strong case that changes in these factors lead to a very significant impact on car use in Sweden. The OECD (2013) report dismisses these factors as being able to explain all peak car effects, across a number of OECD countries. It is not clear what evidence is used to come to this conclusion.	Well known.
Reductions in driving levels for young people	Strong – detailed analysis of observed changes.	Size of impact is unclear, both in short term and in long term.	Some hypotheses of key influences on reductions, but little quantitative evidence on impacts of specific influences.
Developments in land-use	Strong – high agreement among a number of studies that levels of urbanisation have increased, that car ownership and car use are lower in urban areas relative to rural areas, and that young people are more likely to live in urban areas.	Headicar (2013) suggests that the impact of increasing urbanisation on aggregate car use is small. This is corroborated by Bastian and Börjesson (2014) who come to the same conclusion based on their analysis in Sweden.	Some reasons for urbanisation discussed, including development of brownfield sites, increasing promotion of higher densities in new housing development, increasing density of jobs in cities and migration.
Population structure and	Strong – high agreement that: (i) women's car use	Sizes of impacts of trends are unclear. Although a	Licence holding trends for

demographics	is increasing, but women still drive less than men, (ii) the elderly drive less, and (iii) immigration levels increased during 1990s, and that migrants drive less than natives after correcting for location.	number of studies suggest that the impact of migration levels on car travel is important (Stokes, 2013; Bastian and Börjesson, 2014).	women and the elderly are well-understood, but other drivers of changing car travel trends are less well known; little is known about the influences on migrants' travel patterns, and how these will change over time.
Employment levels and patterns	Low.	Not well known.	Unsure.
Information technology	Unclear – Some evidence emerging that telecommuting reduces car usage, but much less known about the impacts of e-commerce and social media on travel.	Some evidence on size of telecommuting market, and the impact of telecommuting on travel patterns, but size of impact more generally is not well understood; less known about the size of impacts of e-commerce and social media on travel.	Little known about influences.
Use of company cars	High, detailed analysis of observed changes in company car ownership and provision of free fuel as employee benefits.	Reductions in company car ownership have had a substantial impact on total household car ownership and mileage driven in company cars, particularly for men, with high income, from 'Employer/manager' and 'Professional' socio-economic groups and particularly in London and the South East (for commuting and business trips). There is little evidence of a net substitution effect between company car and private car mileage for employed men, in aggregate (although some substitution effects are observed for some	Report that reductions in company car ownership are likely to be associated with changes in UK tax policy, but no causality established.

		employment groups, e.g. employers/managers. There is some evidence of a shift from company car to rail. None of the analysis focuses on the impacts of specific journey purposes explicitly.	
Substitutes	Little evidence on how substitutes have influenced car mileage patterns in Great Britain and Northern Ireland.	Unknown.	
Supply effects	Little quantitative evidence on how supply effects, i.e. congestion have influenced car mileage patterns in Great Britain and Northern Ireland.	Unknown.	Some suggestions for drivers of changes in supply.
Changing attitudes	Little evidence on changing attitudes and how these have influenced car mileage patterns in Great Britain and Northern Ireland.	Unknown.	Little known about drivers or attitudes and influences on travel.
Market saturation	Some evidence of market saturation for car ownership, and evidence, at an aggregate level, of saturation for car mileage. However, does not take account of changes that are happening to specific segments of the population, which appear to be very different.	Not well understood.	Not well understood.

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Appendix A – Search protocol

The search protocol used for the study is attached below.

Inclusion and exclusion criteria

A rapid evidence assessment (REA) review aims to be a comprehensive, systematic and critical assessment of the scope and quality of available evidence. REAs follow the same structure and are similarly replicable and transparent as systematic literature reviews, yet have the advantage of being less resource intensive. This is achieved by formally constraining the types of research to be sourced on the basis of the location of the study, the language in which it was published, the date of publication and the type of demand considered. The proposed constraints are detailed below.

Location

The Department have stipulated that the review should focus on UK evidence.

Data of publication

Given that the levelling off in car traffic is a recent phenomenon, the search will be restricted to material published from 1995 onwards to restrict the number of hits to a manageable number.

Demand type

Only passenger demand studies will be considered as the importance of different factors in explaining growth in freight traffic will be different, for example economic factors would be expected to have a stronger impact on freight traffic. It is emphasised that this means passenger demand rather than freight demand (rather than car passenger demand versus demand for other modes).[5]

Mode

The search will be restricted to travel by car.

Search strategy

The literature search will be conducted in a range of relevant databases following the search strategy set out in this section. Grey literature will be searched separately and the search of grey literature is not outlined in this protocol note. Included within the grey literature will be sources identified by the Department:

- RAC's 'On The Move': http://www.racfoundation.org/assets/rac_foundation/content/downloadables/on_the_move-le_vine_&_jones-dec2012.pdf.
- OECD's 'Long-run Trends in Car Use': http://www.oecd-ilibrary.org/transport/long-run-trends-in-car-use_9789282105931-en.
- TfL's 'Drivers of Demand for Travel in London: a Review of Trends in Travel Demand and their causes':

[5] The search is constrained in this way because the TRID database distinguishes passenger and freight studies and therefore the search results can be readily filtered in this way.

https://www.tfl.gov.uk/cdn/static/cms/documents/drivers-of-demand-for-travel-in-london.pdf.

We will also propose to include:

- 'Peak car use in Britain', prepared by Dr Abbi Hobbs and Dr Lydia Harriss, Parliamentary Office of Science and Technology (POST), as a briefing document for the Commons Transport Select Committee, November 2013.
- 'The impacts of urban densification on the supply and demand for transport', slide presentation for the European Transport Conference, prepared by Ian Williams and Ying Jin, University of Cambridge.

The literature search of published material will be undertaken by a trained librarian based in RAND's Santa Monica office in the US. The primary database for the search of journal papers and conference proceedings will be the Transportation Research International Documentation (TRID) database. A draft search strategy is presented below.

Draft Search Strategy

We propose to commence with a literature review of literature focused on discussing car traffic trends, seeking to identify evidence on the key areas associated with these changes, for example economic, along with evidence on the impact of specific factors, for example behavioural and perception changes, cost and income effects, etc.

Search 1 (passenger transport only)

peak car OR peak travel OR travel trends OR traffic trends OR traffic drivers OR car use OR car reduction OR reduction car OR car travel OR decreas* car OR vehicle miles travelled OR annual distance travelled OR car dependency OR car travel behaviour OR car travel behavior

There is a risk that there may be a substantial number of papers identified, even if we focus solely on the UK, and then we may have to include further constraints in the search. This will be discussed with DfT.

If there is further time, we could run separate searches looking for published evidence in specific areas, for example travel patterns, car ownership and/or licence-holding for men:

Search 2 (passenger transport only)

travel OR demand OR traffic OR car OR licence OR license

AND

young men OR young adults OR young drivers

Or, perhaps to search for evidence on the impact of urban densification patterns.

Search 3 (passenger transport only)

travel OR demand OR traffic OR car

AND

urban areas OR urban densification OR spatial distribution OR London

It is not clear to what extent the published research identified in this search will explain why changes are occurring for each of the factors. For example, it is possible that we may identify a geographical factor that says that increasing urbanisation is leading to reduced car levels overall, but that the reasons for increasing urbanisation are not fully explored. We would then recommend further focused searches on specific areas or factors of interest, to be conducted at the completion of the main review.

Study selection and data extraction

Study selection

For this REA, the titles and abstracts of studies identified from the literature search will be screened to eliminate papers that are not relevant in order to come up with a 'longlist' of titles and abstracts for consideration.

The longlist will then be reviewed by senior staff members to identify a shortlist of 18–20 papers for review. A spreadsheet summarising both the longlist and the proposed shortlist will be circulated to the Department and their agreement sought before the data extraction stage commences.

Data extraction

An Excel spreadsheet will be used for the data extraction phase. A data extraction template will be developed and piloted using two or three studies. Data likely to be extracted from each study include:

- Study identification information – number, authors, date
- Factors identified
- Areas identified where further evidence is required.

This is very much a preliminary list. The final list of items for extraction will be agreed on the basis of what emerges from the literature and will be agreed with the Department once data have been extracted.

The first study will be reviewed by both James Fox and Charlene Rohr as a check on the information extracted.

Quality assessment

The quality of each study reviewed will be assessed according to the following criteria:

- Whether the source was peer reviewed – some are likely to be conference presentations.
- Is the research question clearly stated?
- What is the quality of the data?
- Is the methodology appropriate to the analysis and clearly reported?
- Are the results clearly reported with appropriate confidence intervals/measures of statistical significance?
- Are the results reliable and or generalisable?

The quality assessment will not be used as a basis for determining which papers should be shortlisted for review. Rather, the quality assessment will be used in the review to help assess evidence across different sources, particularly if there are instances where the sources contradict one another.

Appendix B – Reviewed articles and reports

The final short-list of articles reviewed included nine journal articles, eight reports and the one conference article identified from the search process, as well as three further grey literature sources identified by the study team and the Department. The 21 different sources reviewed are summarised below (in no particular order).

Peer-reviewed journal articles:

Garceau T.J., C. Atkinson-Palombo and N. Garrick (2014) 'Peak Travel and the Decoupling of Vehicle Travel from the Economy: A Synthesis of the Literature', *Transportation Research Record: Journal of the Transportation Research Board.*

Stokes G. (2013) 'The Prospects for Future Levels of Car Access and Use', *Transport Reviews.*

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Dender, K. and M. Clever (2012) *Recent Trends in Car Usage in Advanced Economies – Slower Growth Ahead?* Summary and Conclusions. International Transport Forum Roundtable on Long-Run Trends in Travel Demand International Transport.

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P. White, G. Christodoulou, R. Mackett, H. Titheridge, R. Thoreau and J. Polak (2007) *The Role of Teleworking in Britain: Its Implications for the Transport System and Economic Evaluation*, European Transport Conference.

Other grey literature

We reviewed the following grey literature identified by ourselves and the Department (i.e. these sources did not emerge from the search of the TRID database):

- TfL's 'Drivers of Demand for Travel in London: a Review of Trends in Travel Demand and their causes': https://www.tfl.gov.uk/cdn/static/cms/documents/drivers-of-demand-for-travel-in-london.pdf.
- 'The impacts of urban densification on the supply and demand for transport' slide presentation for the European Transport Conference, prepared by Ian Williams and Ying Jin, University of Cambridge.
- Bastian, A and M. Börjesson (2014) It's the Economy, Stupid: Increasing Fuel Price is Enough to Explain Peak Car in Sweden. CTS working paper. 2014:15. http://swopec.hhs.se/ctswps/abs/ctswps2014_015.htm