# Travel behaviour trends in Stockholm 1985-2015: The city as a driver of new mobility patterns, cycling and gender equity

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## 1. INTRODUCTION

Inner city trends in car use diverge from suburban and rural trends, see for example (Bastian and Börjesson, 2015). This seems to also be the case in other European countries. Moreover, Sweden, and Stockholm in particular, is a world leader in gender equality as well as adoption of new communication technology, which are two factors driving changes in travel behaviour. Therefore, it is of general interest to study the trend in travel behaviour, and possible drivers, in the City of Stockholm. Changes in travel behaviour emerging from gender equality and new technology might be following in other cities and countries.

We analyse data from three independent travel surveys based on a representative sample of Stockholm County residents, with over 20,000 individuals responding to each survey. The three survey years are: 1986, 2004 and 20151. Respondents report their personal travel on one randomly assigned survey day within the study period as well as their socio-demographics and their access to different travel modes. Respondents are weighted to be representative with respect to age, gender and home location.

Analysis is restricted to individuals aged 16-74, the common age span of the three survey samples. The surveys are sufficiently comparable: The questionnaire design is very similar across the three periods, and survey responses were mostly collected via paper mail-back[2]. The samples match the corresponding census statistics of employment and driver's license shares. Hence, residents with driver's licences and employed residents have the same response rate as others. Further, the share of respondents not making any trips on their survey day is nearly constant in each survey, at 20%. And the number of public transit trips per respondent lines up well with automated boarding count statistics.

We find that the differences in travel behaviour between urban, suburban and rural populations are widening over time. In the dense urban core people seem to adopt a more gender equal, income equal and socially beneficial daily travel

[1] The three survey periods are: March 1986 - March 1987; September 2004 - October 2004 and September 2015 - October 2015. For comparability across the three survey years, the summer and winter holiday periods are excluded from the 1986 data analysis. The response rate declines from 80% in 1986 to 48% in 2004 to 35% in 2015.

[2] A quarter of the 2015 respondents answered the survey online, while the other ¾ decided to mail back their paper survey.

behaviour. We find that car use declines and bicycling increases where economic, housing and activity densities are growing and road space is limited, even without substantial public transit expansion. Thus, congestion can be interpreted as an effect of an attractive growing city. It needs to be managed by policies that allow for the flow of more people in a small space, therefore allocating more space and priority to pedestrians, cyclists and public transit users.

## 2. RESULTS

### Trip location and mode choice

Figure 1 shows that over time an increasing share of the total trips within Stockholm County is entering or exiting the inner city. This agglomeration trend is driven by Stockholm's knowledge economy as well as Stockholm municipality's land-use policy. The spatial concentration of activities and the increased population of the County lead to increased competition for road space in the inner city, despite a reduction in the number of cars entering the inner city with the introduction of a congestion charge in 2007.

Travel speeds in Stockholm County have declined slightly between 2004 and 2015 for cars, busses[3] and bicycles but not for rail based public transit. Similarly, in inner London traffic speeds have not increased since the introduction of the congestion charge in 2003, despite a 20% reduction of inner London road traffic between 1999 and 2012. The London Transport Authority attributes this to a reduction in effective road network capacity "with space having been reallocated from general motor traffic to other purposes such as bus and cycle lanes, safety initiatives or improvements to the public realm" (Transport for London, 2015a, p. 24).

Figure 2 shows how mode shares of trips have changed over time, depending on the location of the trip. Bicycles continue to gain trip shares and distance shares from cars for trips within and entering/exiting the inner city. Since 2004 public transit gained trip shares and distance shares from cars for trips outside or passing through the inner city. Similar mode shifts have been observed for inner and outer London respectively (Transport for London, 2015b).

Figure 3 shows the average length of trips within Stockholm County by mode. The average length of trips within Stockholm County increased significantly for all modes from 1986 to 2004. Such trends have been seen in many counties over a long period. However, car and bicycle trip lengths have declined in the regional centre between 2004 and 2015. The increased agglomeration thus enables shorter trips, and increased road congestion is an incentive to reduce trip lengths.

[3] Bus travel times for the same routes increased by 6% during peak hours from 1998 to 2006 (Stockholm Transport Administration, 2009)

Figure 4 shows that bicycling increases among the middle aged and decreases among the young. Bicycles are increasingly used for commuting, particularly to reach jobs in the inner city. Of the total bicycle distance travelled in Stockholm County nearly 63% was for commuting purposes in 2015. Bicycles accounted for 11% of commuting trips and 5% of commuting distances in Stockholm County in 2015.

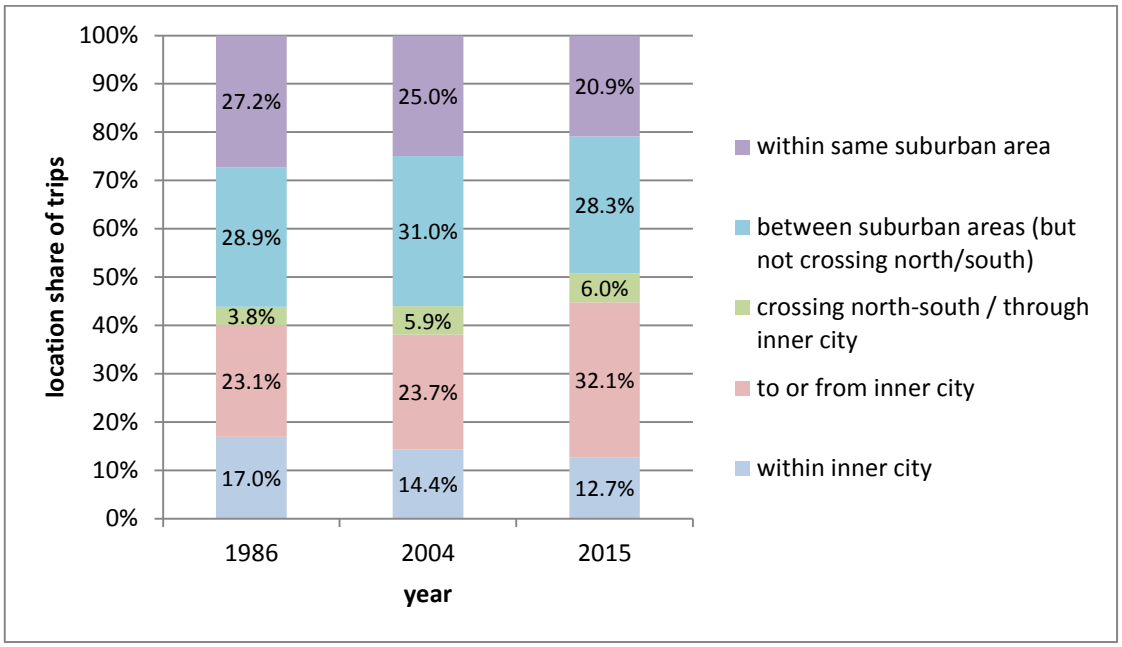



*Figure 1: location share of trips within Stockholm County by year*

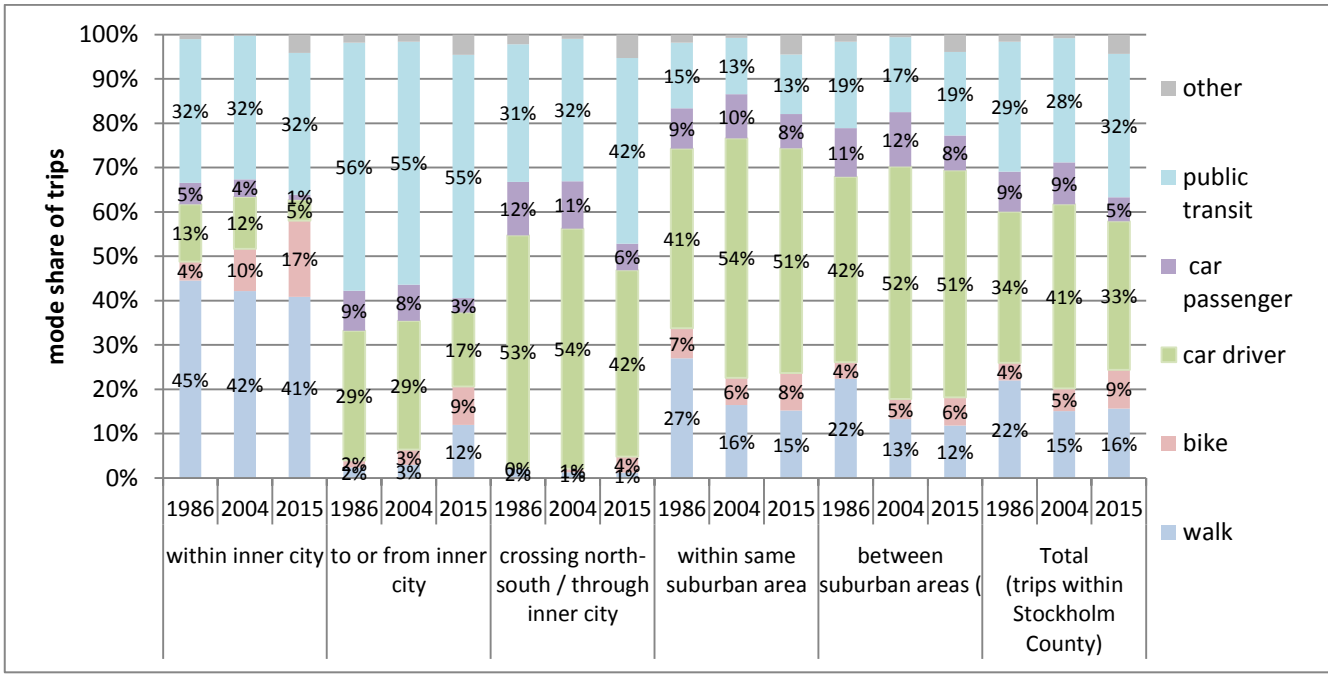



*Figure 2: mode share <u>of trips</u> within Stockholm County, by trip location and year*

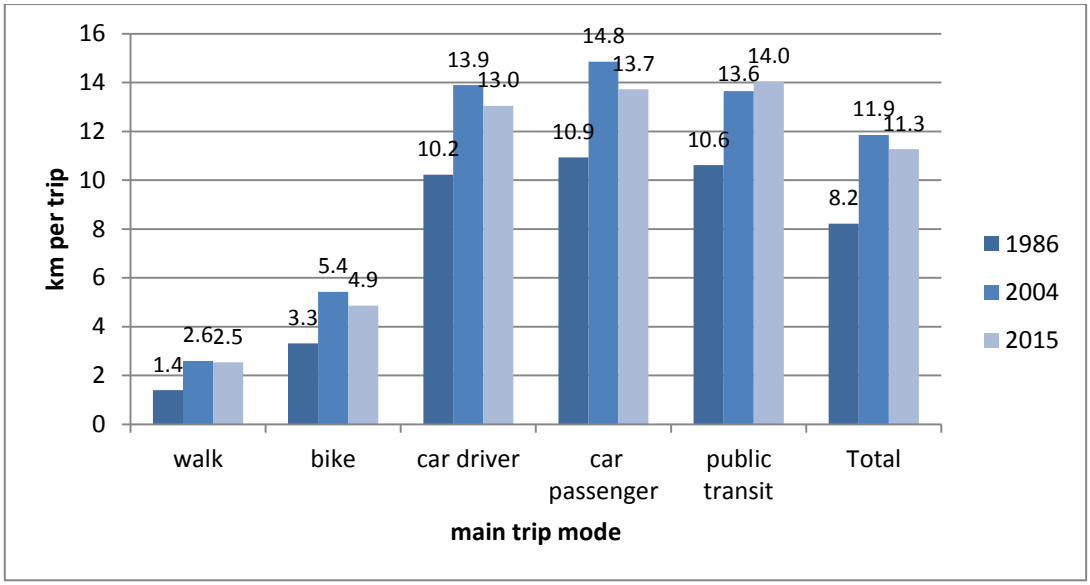



*Figure 3: Mean distance per trip within Stockholm County, by main mode and year*

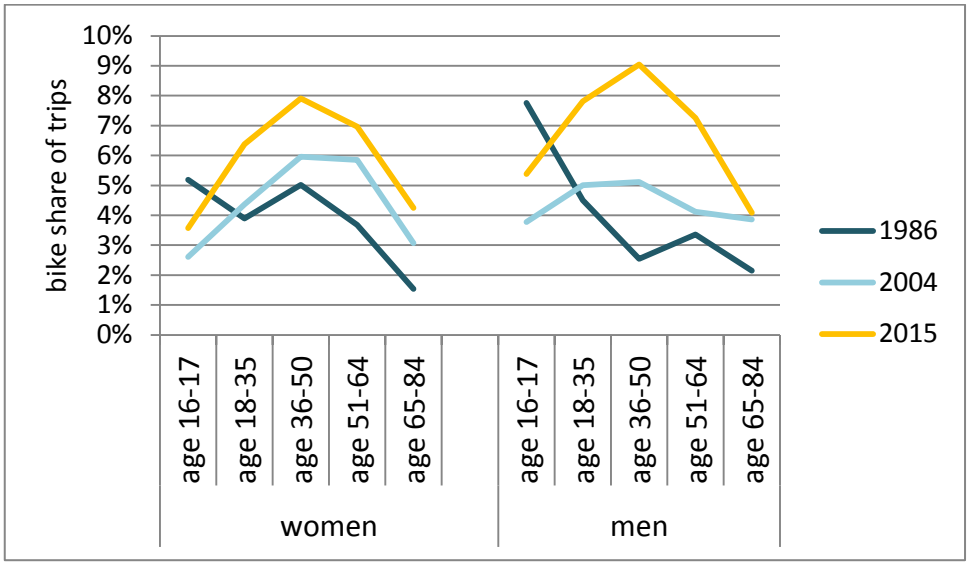



*Figure 4: bicycle share of trips within Stockholm County, by age, gender and year*

## Trip Frequencies

Figure 5 shows trip frequencies (the number of trips per person per day) in Stockholm County by gender and trip purpose. The significant decline in commute trip frequency from 1986 to 2004 can be explained to more than half by fewer activity breaks during the work day, thus more workers only commuting to work once per day. Trip frequencies decline for all purposes, but especially for shopping, leisure and service and especially among younger adults. Between 2004 and 2015 the decline in shopping trip frequencies was strongest for non-food products.

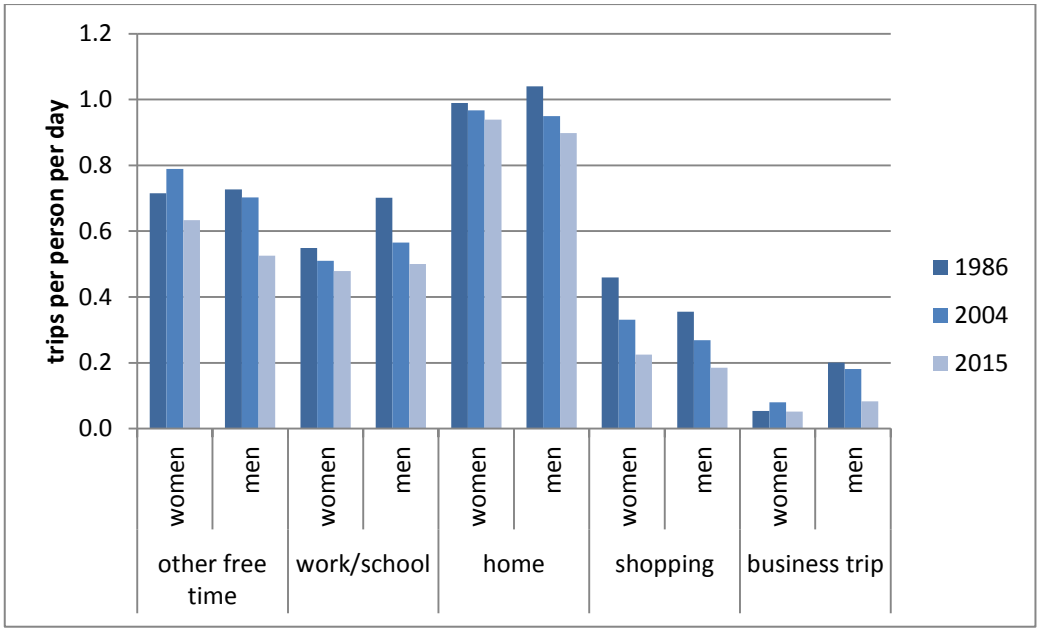



***Figure 5: trips per person per day, by gender, trip purpose and year, among ages 16-74 in Stockholm County***

## Car use

As shown in the trip location sub-section, car shares of trips and distances in Stockholm County have increased between 1986 and 2004 but then decreased again between 2004 and 2015, back to roughly similar average levels than in 1986. Yet, spatially car travel looks very different in 2015 than in 1986. Fewer cars are entering or exiting the inner city in 2015 than in 1986, despite a 40% population growth in Stockholm County. Instead, car use has shifted to the suburban areas. Trips that remain in the suburban regions south or north of the inner city have a higher car share in 2015 than in 1986.

Figure 6 shows the car share of trips by residential location, household income and gender for the years 2004 and 2015. During this time car shares of trips and absolute trip counts have significantly decreased among all income groups, particularly among men and among women above the lowest income quartile.

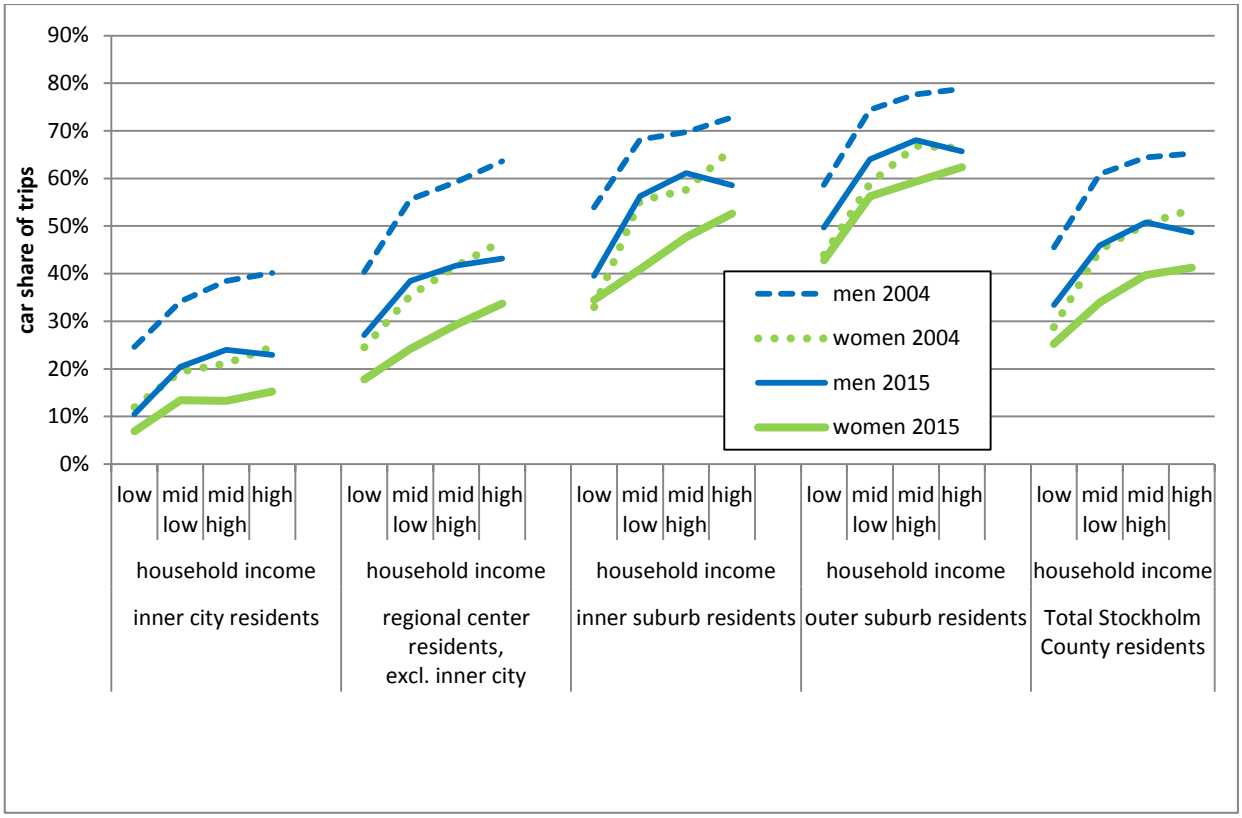



***Figure 3: car share (driver or passenger) of trips within Stockholm County, by residence location, household income and gender and year***

## Commuting distances

Men travel farther than women to reach suburban job locations. In rural areas of Sweden the gender gap in commute distances is not declining. However, figure 7 shows that for employees in the region centre of Stockholm, there are no gender differences in travel distance.

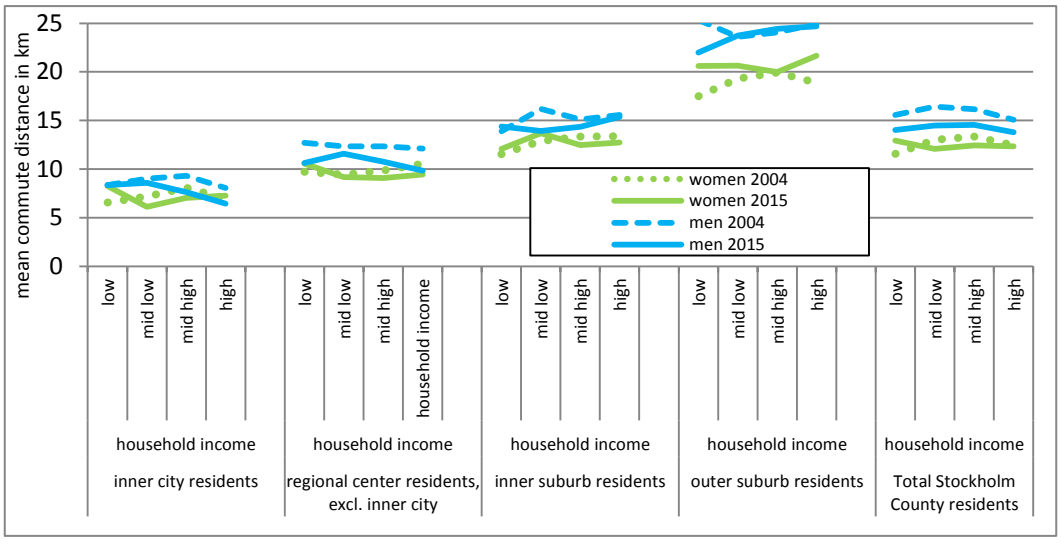



***Figure 7: Mean commute distance among employed adults, by residence location, household income, gender and year, for trips within Stockholm County***

To: The Commission on Travel Demand

Submission by Bill Wyley MA FCIHT MICE Past Chair TPS

**Preamble**

I suspect that this submission will be rather different from most submissions that you receive. That is because it constitutes a request that the Commission should explore, not only ways in which demand for transport may be changing, but also the validity of historic and current assumptions regarding that demand, ie the essential starting point for understanding and assessing change.

**My Submission**

More specifically, and as an experienced senior member of the transport planning profession, I wish to formally request that the agenda for the work of the Commission includes an objective, open-minded review of the Travel Time Budget (TTB) hypothesis. The most appropriate starting point for this review is probably Dr David Metz' paper 'The Myth of Travel Time Saving', published in Transport Reviews in 2008 and available on-line. However, that is only the most recent, so far as I am aware, of a history of relevant research and publications dating back to Marchetti (1994) and Zahavi (1973-1980).

**Background**

Transport Planning, certainly in so far as it is concerned with investment in infrastructure, involves two significant strands of activity – demand forecasting and scheme appraisal. While both have evolved significantly over my working lifetime of 40 years, changes have been largely incremental; and have continued to be based on the fundamental premise that travellers endeavour to reduce travelling time, and that those savings can form the principal basis for economic appraisal.

So far as the second strand of activity is concerned, the last 10 years have seen growing debate, and associated developments in methodology, regarding the appropriate balance between time savings and 'wider economic benefits', as recently illustrated by the DfT consultation on draft Wider Economic Impact guidance.

So far as demand forecasting is concerned, however, minimal consideration appears to have been given in recent years, by either government, other academics or practitioners, to the series of research based papers to which I referred above, and which directly challenge the 'accepted wisdom' that new and improved infrastructure and services result in travel time savings.

**The Work of the Commission**

I think it is appropriate, at this point, to explain that I am not arguing, at this time, that the TTB hypothesis is correct – I do not have access to the necessary resources to come to that conclusion - but that the hypothesis should be given rigorous consideration, on the basis of

appropriate data capture and analysis collated, specified or undertaken by the Commission. Indeed, it seems to me that data collation and analysis designed to 'understand how new types of demand are emerging and old types of demand disappearing and the influences on these processes' should also, inter alia, be able to illustrate and explain the mechanisms which have driven demand over past decades, and thus confirm or rebut the TTB hypothesis. At this point I should add that it seems possible to me that the TTB hypothesis could well help to explain the very substantial difference between observed traffic growth on peripheral motorways, such as the M25 and M62, and other categories of road.

The above does, of course, raise the question of what evidence will be brought to the Commission as a result of the current 'call' and the quality of the ensuing debate, given the planned time-frame of a single year. But that is a matter for future consideration rather than this submission.

**Looking Further Ahead**

If the short-term work of the Commission were to provide positive indications in relation to the TTB hypothesis, then then that would have very significant implications, not only for additional work to confirm, or otherwise, those indications, but for nearly all aspects of the current complex of demand forecasting and scheme appraisal methodologies. But that would also be a matter for future consideration, rather than this submission.

Bill Wyley 29-1-'17

**Preliminary Observations from Bristol City Council**

**Commission on Travel Demand**

**February 2017**

**Figure 15:**
**Change in transport use**
**(Percentage growth since 2008/09)**

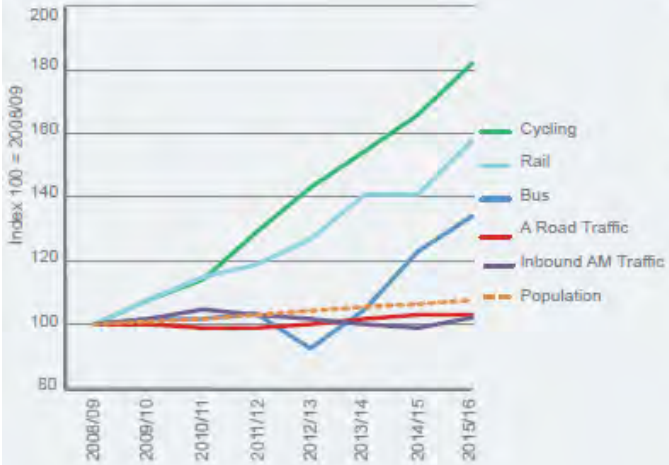
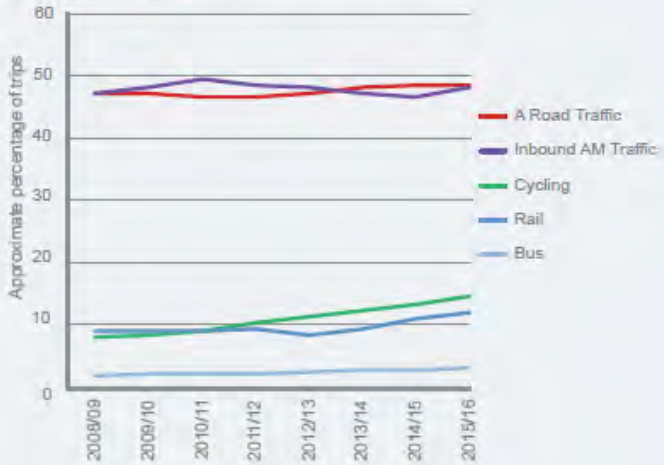



**Figure 16:**
**Change in transport use by mode since 2008/09, by total mode share**




*Note error in legend - bus is dark blue and rail light blue

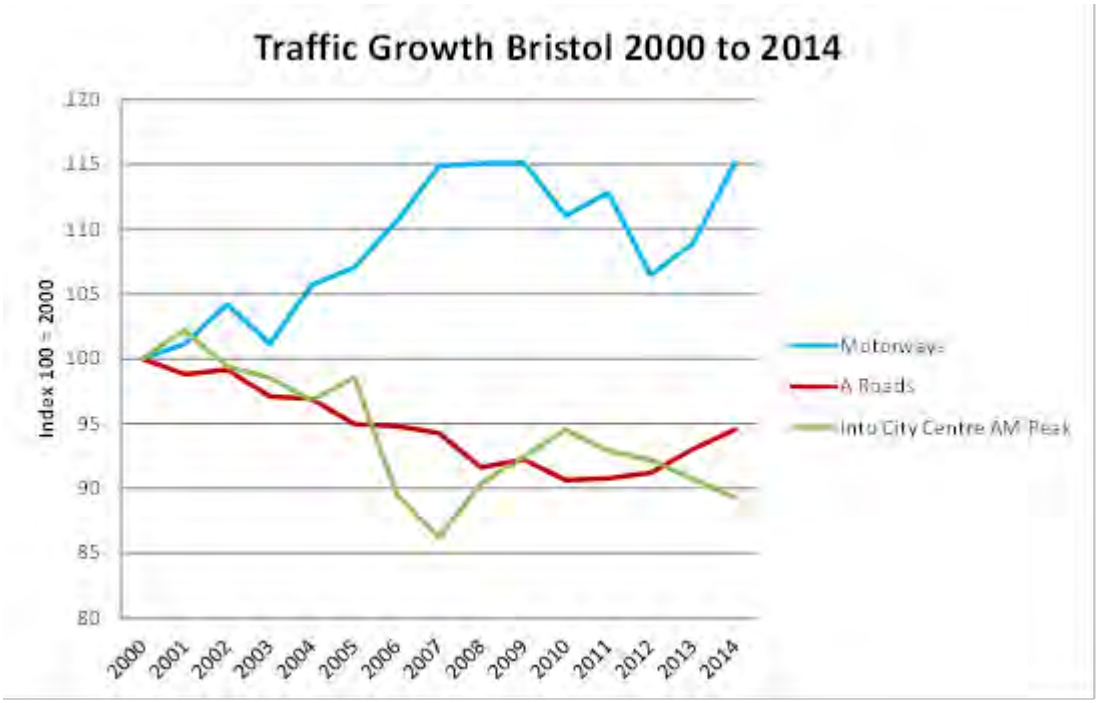



**Figure 12: Change in road traffic, by road type**

The volume of traffic on major roads across Bristol has remained relatively constant since 2000, however, this masks big differences between road types. Traffic on Bristol's Motorways has risen by 15% since 2000, whereas traffic on A roads has dropped by 6%. Traffic entering the city centre in the AM peak (07:00-10:00) has dropped by 11%.

This reflects national trends over the same time period, which have seen traffic on motorways substantially increase, with small decreases on urban A roads and minor roads.

This also highlights that national traffic growth forecasts are not accurate for Bristol. For example, between 2001 and 2015 an increase in traffic of 6% was forecast by central government for Bristol via software called TEMPRO, but no increase was recorded. TEMPRO currently predicts 22% growth in car use in Bristol City Council area between 2015 and 2036, however, this is not consistent with the observed trend over the last 15 years.

Chris Mason

Campaign for Better Transport

# Commission on Travel Demand
# Response from Campaign for Better Transport

Campaign for Better Transport and its predecessor Transport 2000 have been concerned with the issue of travel demand for many years. We have been critical of traditional approaches to travel demand, and have argued that they miss key trends and also treat demand as far more fixed than it is. We have also argued that on sustainability grounds past trends in travel need to change. We therefore welcome this Commission and are keen to help it with its deliberations.

The main areas where we believe traditional approaches to forecasting demand are vulnerable are as follows:

- Land use change: traditional modelling and forecasting methods ignore the influence on travel demand of different patterns of development and land use, and the feedback between transport investment and development. Yet there is good evidence that the siting and design of development can have huge influence on travel demand[1]

- Provision of transport choices: traditional methods tend to downplay the importance of travel choices. The traditional DfT line is that "road and rail largely serve different markets", and we see even now that the development of a road and a railway between Oxford and Cambridge is being pursued separately. Projections for HS2 assume very little mode shift from car and air, despite the step change in speed and capacity it represents. The National Networks National Policy Statement states that even if rail freight were doubled it would only reduce road freight by 5%, and a similar statement is made for passenger rail. Work we have commissioned, some of it with DfT, has shown that this is wrong, and that for specific corridors and areas a growth in railfreight could reduce road freight significantly. Similarly, we have seen that traditional rail forecasting tends to systematically underestimate demand for new/reopened lines and stations.

- Networks: traditional methods tend to focus on individual links rather than networks and door to door journeys. This means that when there are improvements to whole networks traditional methods will miss their significance. This is one of the factors in London where there have been large changes in demand outside the forecasts. This is not just about the provision of infrastructure, but about pricing. The move towards smartcards, zonal fares and network-wide ticketing leads to effects entirely outside traditional methodology. Simplification of pricing, especially on public transport, drives business. The inclusion of national rail services in the London Oystercard, and the provision of flat £2 fares offer in Merseyside for young people, were both predicted to result in revenue loss, but in fact produced gains. Conversely, the effect of provision of, say, extra motorway capacity will miss the effect on surrounding road networks.

[1] See e.g. http://www.bettertransport.org.uk/sites/default/files/research-files/Masterplanning_Checklist_2008.pdf

- Economic and demographic trends: income and wealth distribution between age groups (young/old), between sexes and ethnic groups and between different types of area, will have big impacts on travel demand but have not been well studied. Consequently measures that seek to help lower income groups of all kinds have a poor analytical base and the implications for travel demand have not been well studied. Similarly the impacts of, for example, the expansion of higher education, the loans used to fund this, the high housing costs faced by young people and the casualization of employment are together having an impact on travel demand by young people.

- Technology: this is one area where the vulnerability of traditional methods of forecasting and modelling travel demand is already apparent. Retail trips are already falling and van travel increasing with the growth of internet shopping. As already noted, smartcard and mobile phone technology is changing travel behaviour with respect to public transport. Information availability through apps like citymapper and many others make choices much more transparent. There are various other technology developments under the broad headings of big data, mobility as a service and connected/ autonomous vehicles which separately and together have the potential to change travel demand and travel behaviour dramatically. It is not clear that conventional methodologies can handle the very wide range of uncertainties that these technologies imply. One outcome that is almost certainly ruled out is that current travel patterns will continue – in other words, that current car-based mobility, including current occupancy levels and trips, will continue and grow, but merely in electric and autonomous rather than piloted vehicles with petrol or diesel engines. Yet that seems to be the default assumption of transport professionals and policymakers.

- Behaviour can be changed by policy: conventional methodologies link travel demand to income, GDP and motoring costs, leaving little hope for policies (other perhaps than national road pricing) to change demand. Yet it is clear that policies have changed travel behaviour. These policies include national measures e.g. (changes in company car tax) and local (smartcards, parking policies, provision of cycle infrastructure and better/ cheaper public transport). There is significant literature around this, including smarter choices and the Local Sustainable Transport Fund analysis.

From this, we suggest that there are widespread influences on travel demand that are not captured, or captured poorly, in conventional methodology.

DfT has recognised some of this and is researching some of it. The introduction of scenarios (in NRTF 2015) has started to address some of these points. However there is little sign yet that the uncertainties around future travel demand are being dealt with systematically. More importantly, there is almost no sign of these uncertainties being reflected in the development and appraisal of schemes on the ground. The schemes now forming part of the Road Investment Strategy or the local growth funds have no futureproofing. While there is some questioning of convention and development of alternative approaches in city regions and bodies like Transport for the North, most strategic and scheme planning is still being done assuming that past trends continue. These assumptions in turn feed into appraisal, especially projected time savings for travellers, which are likely to be wholly erroneous (and of course have been subject to other criticisms). This is likely to involve a significant waste of public spending, aside from the sustainability arguments that the Commission sets out so cogently.

DfT staff do not need to go far to see how vulnerable conventional forecasting of travel demand is. The ground floor of their offices in Marsham Street/ Horseferry Road in London used to be occupied by a car showroom, which would fit with the old style traffic forecasts. This has now been replaced by a

Sainsbury's local store, which is a feature of the retail changes unforeseen by those forecasts, and a kitchen furniture showroom to serve the city centre residential developments also outside the old forecasts.

In summary we welcome the Commission, have identified some of the issues it might look at, and believe that the best way forward is to develop much better scenario planning reflecting a wide range of uncertainties.

February 2017

Stephen Joseph
Campaign for Better Transport

Campaign for Better Transport's vision is a country where communities have affordable transport that improves quality of life and protects the environment. Achieving our vision requires substantial changes to UK transport policy which we aim to achieve by providing well-researched, practical solutions that gain support from both decision-makers and the public.

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# Civil Aviation Authority's response to the Commission on Travel Demand's call for evidence on understanding travel demand

## Summary


1. The CAA welcomes the opportunity to respond to the Call for Evidence in January 2017 by the Commission on Travel Demand who is exploring "the changing demand for transport, the reasons for it and to debate new approaches to planning for and shaping demand futures which support social and economic progress whilst being consistent with our environmental obligations".
2. The CAA is the UK's specialist aviation regulator. Our regulatory activities range from making sure the aviation industry meets the highest technical and operational safety standards to preventing holidaymakers from being stranded abroad/losing money because a tour operator fails. We are also responsible for the Economic Regulation of Airports (Heathrow and Gatwick) and of Air Traffic Control.
3. While we are not in a position to fully contribute to all the questions raised in the consultation, we thought it would be appropriate to make a number of considerations from our perspective.
4. We are happy to engage further with the commission and wish that its work is fruitful. If you would like any other clarification and/or would like to discuss the contents of this submission please contact Pedro Lino Pinto.


## Domestic Aviation

5. The call for evidence discusses the evolution of emissions of domestic travel. Domestic travel accounts for a small proportion of total airport passengers in the UK. There are only about 2.2m passengers per year travelling between UK airports which compares with about 210m travelling between a UK and an International destination. Even then, a sizeable proportion of passengers travelling between UK airports are not making a domestic travel journey. Many are travelling on a domestic route to then connect to/from an international route.

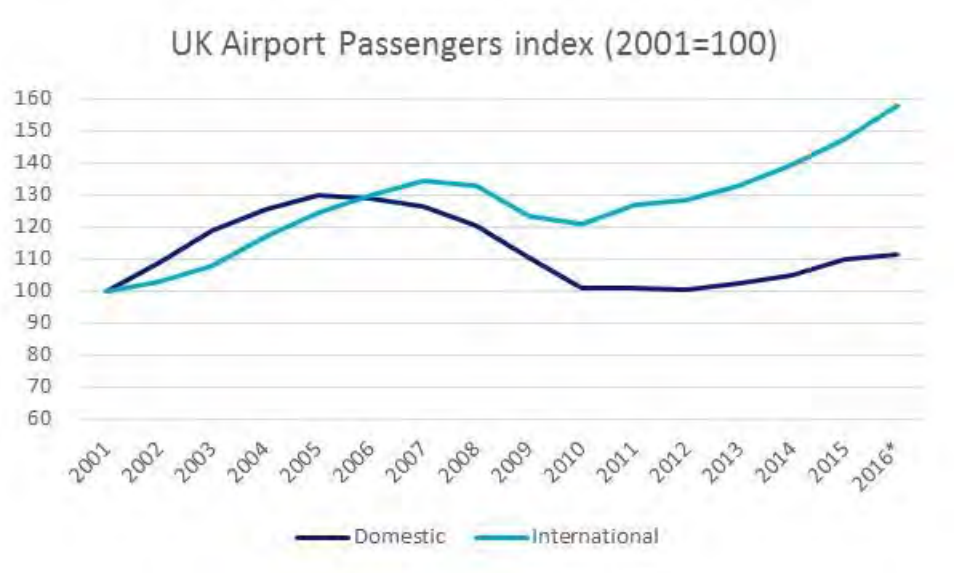
6. One aspect of the domestic aviation that often attracts interest is the availability of air services between the UK nations and regions and hub / London airports, particularly Heathrow. Some of these routes are seen as important not only because they provide access to London but because they also provide the regions with access to onward travel options at the hub airport. In recent years, the development of domestic routes at Heathrow, in particular, have been under pressure given the well documented runway capacity constraints, which may have meant that scarce slots have been increasingly used by airlines to serve longer haul destinations. We have recently published a note on these issues that may be relevant to the Commission's work.[1]

**Recent developments in UK airport passenger numbers**

7. Overall passenger numbers at the UK's regional airports grew rapidly in the years leading up to 2007 by taking advantage of the growth of low-cost airlines increasing their connections to European destinations.[2] However, airports outside London were generally more affected by the economic downturn of 2008, but since then passenger numbers have recovered so by 2015 they were just a little below their pre-2008 peak.

8. As shown in the figure below, domestic travel in 2016 was only about 11 per cent higher than 2001 levels, while International Air passengers were about 58 per cent more. In addition domestic passengers have consecutively declined between 2005 and 2012 and have grown at a slower pace or fallen faster than international aviation since 2004.

[1] See www.caa.co.uk/cap1413.
[2] This growth in connectivity was described in-depth in www.caa.co.uk/CAP754 in 2005 and in www.caa.co.uk/CAP775 in 2007.




Note: 2016 data is for January to October

Source: CAA Airport Statistics

**Capacity Constraints in the Southeast of England**

9. We agree with the Airports Commission conclusion that new runway capacity in the South-East of England is important to unlocking a greater number of both domestic and international connections and the economic benefits they bring. We would also stress the importance of airspace modernisation.

10. That said, airlines and airports have responded to the commercial incentives posed by the increasing runway capacity constraints. For example:

- Airlines have continued to adapt their networks to serve the most profitable routes, with increased aircraft size and sector lengths.
- Airlines have been able to trade slots in such a way that they end up being operated by those airlines who are willing to pay the most for such slots.
- Airport operators have structured their charges to encourage a higher utilisation of their scarce runway capacity.

**Market Maturity**

11. Historically, air travel tends to grow faster than GDP, but has matured over the years. In the recent years, UK air passengers have grown at about 1.5x GDP growth. Domestic travel particularly is particularly mature, with average growth in domestic air travel being typically lower that GDP growth.

**Aviation contribution to meeting carbon targets**

12. Aviation contributes around 6% of UK carbon emissions, with domestic aviation responsible for just a small fraction of it.[3] Aviation is different to other sectors of the economy since while some there are already some technologies that would allow for significant shift of energy sources, in aviation, jet fuel is likely to remain the predominantly source of aircraft energy.[4] Therefore aviation contribution to carbon reduction is likely to come from increased engine efficiency, air traffic improvements and, crucially, carbon offsetting in other industries.
13. As the CCC, we agree that policy approaches to aviation emissions should be primarily decided at the global or EU level, given the international nature of the industry.
14. Finally we note the conclusion of the Airports Commission that "one new runway [at Heathrow], even fully utilised, is compatible with continued progress towards reducing carbon emissions". It also notes that "[the runway] will provide the capacity we need until 2040 at least. Beyond that, the position is uncertain, and will be strongly dependent on the international policy approach to climate change".[5]

**Air – rail substitution**

15. A way of reducing aviation use is obviously to increase the share of rail travel on very short air routes. Improvements in rail services have the potential to reduce aviation emissions at the margin. Research shows that

[3] See https://www.theccc.org.uk/charts-data/ukemissions-by-sector/aviation/.
[4] Even though some research and testing has been done for the use of biofuels in aviation.
[5] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440316/airports-commission-final-report.pdf

when rail travel times fall to less than about 3-5 hours rail becomes the predominant way of point-to-point travel.

16. We've observed reductions in air travel in domestic aviation and on aviation services to Paris and Brussels form the Southeast of England when rail improvements occurred.[6]

[6] See, for example, slide 9 of https://www.caa.co.uk/uploadedFiles/CAA/Content/Standard_Content/Data_and_analysis/Analysis_reports/Aviation_trends/AviationTrends_2008_Q2.pdf.

Committee on Climate Change

Professor Greg Marsden
DEMAND
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27 February 2017

**Commission on Travel Demand**

**Dear Greg**

We said we'd write to set out the main issues relating to Travel Demand that are of interest to our work at the CCC.

As you know, much of our work concerns advice on setting carbon budgets and monitoring progress reducing emissions. This means our interests lie in looking at trends in demand, monitoring drivers and thinking about future changes – what might demand look like in the future and why. Our advice on emissions trajectories is against the requirement in the Climate Change Act for overall emissions to be reduced at least 80% on 1990 levels in 2050. This note sets out four key areas of interest to us in this context:

1. Forecasting transport demand
2. Drivers of demand
3. Types of demand and reasons for trips
4. New sources of demand

**1. Forecasting transport demand**

Projections of future travel demand are an important starting point for our advice on setting carbon budgets. We therefore need to know about different potential future scenarios of demand and associated risks and uncertainties. As we rely on the DfT National Transport Model for baseline projections, we need to be able to understand the basis for developing particular scenarios and the justification for their 'central' scenario, as well as understanding the range of possible futures.

More generally, we're also interested in how to capture social trends and lifestyle changes such as internet shopping or increased home working. The higher concentration of people living in urban areas could also affect how and why people travel.

Whilst the NTM uses car ownership as the basis for forecasting demand, it would also be interesting to consider alternative models. For example the starting point could be on trip patterns, rates and purpose and how these might change across modes and different groups going forward.

Projections are always uncertain and carbon budgets need to deal with all kinds of uncertainty, not just in demand. We would be particularly interested to see new approaches to take account of future uncertainty, how this affects our trajectories to meeting legislated emissions targets and what this implies for developing 'no regrets' options.

**2. Drivers of demand**

Monitoring underlying drivers of transport demand is a key area for our progress reports. The main drivers we look at are income (GDP, manufacturing output) and costs (fuel prices and fixed costs). Comparing the impact of those drivers with out-turn demand for the same period does not always give results that we might expect, and this has raised a number of issues for us:

- Are the elasticities underpinning the models ''right'' and how do these compare against external research?
- Are they sufficiently disaggregated (e.g. by age, region) to be useful as a forecasting tool?
- Are they consistent over time, if not, what lessons do we learn from past changes?

Another issue around drivers is whether the modelling fully represents interactions between different types of demand, and whether these interactions are well understood. For example, are the cross-elasticities of demand robust and do they take account of all the potential considerations people make when deciding on one mode over another? This would include things that are potentially difficult to quantify such as public transport wait times and reliability, congestion, cycle path availability and steepness of routes, which vary significantly across the country. What is the potential for the models we use, if they do not take account of the wide variation of factors, to over- or under-estimate car demand?

**3. Demand types**

The data collected in the National Travel Survey provide detailed information on trips by age, region, income group, mode and purpose. It would be useful to consider other key factors that might develop a richer picture of demand. For example, it would be interesting to see whether additional information on factors such as household type, employment status and information on public transport services by region are also important to incorporate in models.

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The NTS shows that trip rates have fallen to an all-time low in 2015, and have been falling steadily since they were first measured in 1995/97. The issue of peak car has been cited as one possible explanation for this, but there could be others. Until we have a good handle on this, it remains a risk in our forecasts and an area where further work would be useful.

Our abatement options not only rely on new low carbon technologies being taken up, but also some reduction in demand and modal shift to public transport and active choices. In developing our scenarios, it has been difficult to find good evidence on what works in terms of incentivising modal shift. While infrastructure and local planning plays a role, these do not provide sufficient explanation for the differences across regions. Research and other evidence, perhaps drawing on behavioural literature, might be useful resources to explore.

An issue CCC has highlighted in recent progress reports is the strong rise in LGV demand and trips. We have done some work in trying to explain this through the rise in internet shopping and possible impacts of changes in regulations around HGVs, such as the more stringent licensing and operating conditions introduced in September 2009. However it's not clear whether these factors fully account for the observed trends, and further work in this area would be helpful.

The data on HGV trips and demand is less detailed, timely and reliable than that for cars and vans, and this affects our understanding of trends and drivers. Whilst low-carbon technologies are key to decarbonising this sector in the longer term, short to medium-term options cover reducing HGV tonne-kms. We have done some work on this, but a better understanding of how to achieve this, e.g. through more efficient routing, consolidation centres, last-mile deliveries, freight to rail options would help to develop our advice in this area.

**4. New sources of demand**

As well as thinking about current drivers of demand, we need to consider the impact of potentially bigger shifts in social and economic trends that might lead to new sources of demand and travel patterns. These could include:

- Autonomous and connected vehicles – how do we develop scenarios to take these into account?
- The impact of large infrastructure projects – HS2, 3rd Heathrow runway, Cross-Rail, plans from Transport for the North?
- The sharing economy – effects of increased car sharing, uber pool and car clubs?
- Road pricing and congestion charging including charging in clean air zones?
- Brexit impacts – how might this impact international freight?

If we could understand the dynamics of these and how long it takes for these effects to filter into functions that can be used in forecasting, or scenario building, that would be a big step forward. There is a link here to uncertainties raised earlier. For us, it will be important to consider how uncertainties in future demands affect the advice we should be giving now, for carbon budgets consistent with the long-term 2050 target.

We hope this helps in steering the important work your Commission doing and we look forward to working with you going forward.

Yours sincerely,

A.R. Gault

Adrian Gault

Chief Economist, Committee on Climate Change

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# Submission of Evidence to the Commission on Travel Demand

*David McKenna, Studio Associate Director, IBI GROUP, The Plaza, 100 Old Hall Street, Liverpool L3 9QJ, United Kingdom david.mckenna@ibigroup.com*

I am a Chartered Landscape Architect and Chartered Engineer with 30 years' experience working for a multi-national firm, I am based in the northwest of England. I have two particular areas of interest in regard to how travel demand affects my areas of work:

- The design of streets and public spaces in towns and cities to balance the needs of various functions and users
- The impact of housing and transport infrastructure on the countryside as pressures for where people want to live change in response to changing patterns of travel

## THE DESIGN OF STREETS AND PUBLIC SPACES IN TOWNS AND CITIES

The traffic on our streets has steadily increased over the last few centuries to the point where traffic often dominates a street over traditional functions social and commercial function. The standardisation of highway design, speed and number of vehicles on the street inhibit these other functions and detract from a sense of place. I have been involved in a number of projects that aim to deliver a more balanced environment that accommodates traffic but responds to different priorities in streets and spaces, to create more adaptable, resilient places.

In this evidence I will explore two themes that are relevant to my work:

- How to balance the social and economic functions of town/city centre streets and spaces with traffic demands
- Will the advent of autonomous vehicles have detrimental impacts on public health? How will the design of our streets encourage active modes of travel in the future when people can choose to travel door-to-door in autonomous vehicles

### *How to balance the social and economic functions of town/city centre streets and spaces with traffic demands to create resilient urban environments*

Historically streets and public squares were the places that trade and social interaction took place as well as conduits where people and goods were moved. The future functions of our High Streets and public spaces is very uncertain as well as the levels and types of traffic so how can we design more resilient streetscapes?

Pedestrians would once have felt comfortable in the whole width of a street, happily stopping to chat in the middle of the road sharing the whole space with low levels of horse and cart traffic. As horse and cart traffic increased, the middle of the street became a less pleasant place to stand and chat, the physical space of the street was divided up with pedestrians allocated a portion on the edge of the space. As motor traffic came along,

travelling at higher speeds and in greater numbers, sometimes the space was further divided using guard railing and the pedestrian space reduced to allow more room for vehicle movement or parking.

We have designed a number of projects that, in key areas of towns and cities, aim to attribute more space to pedestrians, whilst accommodating traffic, such that people feel more comfortable spending time in the streets and spaces ultimately to encourage them to spend more money in the local shops stimulating economic regeneration. These streets and spaces are designed such that they appear as pedestrianised spaces so that people use the whole space and vehicles entering the street/space, do so slowly and cautiously respecting the pedestrians right to the whole space. Effectively rather than physical division of the space, it is shared on a temporal basis. This can be a more adaptable, resilient approach compared to physical division of the street. Pedestrians get to use the whole space when there is little or no traffic or when pedestrian numbers are high. Pedestrians use less of the space when vehicle numbers are higher. An adaptable approach such as this is better at responding to uncertain future traffic demands and as the function of our town/city centres change in response to different social and economic conditions.

*Below: Pedestrians comfortable to chat whilst traffic negotiates its way aound them in Castle Square Caernarfon*


*Above: Before and after views of Castle Square Caernarfon*

*Below: Before and after views of Frodsham Street in Chester where a pedestrian priority environment was designed to encourage people to spend more time and hence money in the street and to make a more attractive historic environment to increase tourism whilst accommodating limited traffic.*


*Below: Before and after photographs of Exchange Square Kidderminster, previously dominated by the carriageway, vehicles still pass through the space but it is designed to appear as a pedestrian space respecting the historic buildings where people are comfortable anywhere in the square*


***Will the advent of autonomous vehicles have detrimental impacts on public health? How will the design of our streets encourage active modes of travel in the future when people can choose to travel door-to-door in autonomous vehicles***

Currently motor vehicles impact negatively on pedestrians and cycles due to safety and pollution issues as well as creating an unattractive environment. There is though, a place for active travel, which improves public health, either in the first/last mile connection to public transport. Also, congestion, as it increases journey times, tends to encourage people to use more active forms of transport. Future transport scenarios that include autonomous electric vehicles will probably create a safer, less polluted environment for pedestrians and cyclists but in a number of instances the motivation to undertake active travel will be reduced:

- the realisation of a door-to-door service will make redundant the active first/last mile of a journey.
- a reduction in journey times due to a lack of congestion or faster travel speeds will make people less likely to choose active forms of transport that will become relatively slower
- the ability to undertake tasks or to sleep in autonomous vehicles will make this form of transport more attractive than active forms
- if travel speeds in autonomous vehicles increase, so people will start to live further from there place of work or other facilities making active travel impractical as an alternative.

There is enormous uncertainty what the unintended consequences of autonomous vehicles will be but there will almost certainly be unforeseen reactions.

There are limited incentives that we can offer to encourage active travel but improving the quality of our streets, such that a cycle or walking experience is pleasant and attractive and which encourages social interaction providing opportunities for trade.

**THE IMPACT OF HOUSING AND TRANSPORT INFRASTRUCTURE ON THE COUNTRYSIDE AS PRESSURES FOR WHERE PEOPLE WANT TO LIVE CHANGE IN RESPONSE TO CHANGING PATTERNS OF TRAVEL**

Will people commute larger distances if they can perform other tasks whilst in transit or if travel speeds increase? Will remote, attractive areas become more accessible to commuters resulting in more pressure to build houses and transport infrastructure in sensitive landscapes. How do demand forecasts take account of changing patterns in behaviour due to the removal or reduction of a constraining factor? How do we plan our infrastructure and housing needs in the context of such uncertainty and how do we ensure we have in place protections for sensitive environments?

# Determinants of travel demand

*David Metz, honorary professor, Centre for Transport Studies, University College London*

This note responds to the request for submissions by the Commission for Travel Demand. It is largely based on the author's analyses previously published.

The National Travel Survey (NTS) has been tracking average travel behaviour by all modes (except international air) for the past 40 years. The key parameters are shown in Figure 1. Both trip rate and average travel time have held broadly unchanged at 1000 journeys a year and an hour a day respectively. The average distance travelled increased steadily until the mid-1990s, mainly the consequence of private investment in vehicles and public investment in roads. This permitted faster travel and hence further travel in the unchanging amount of travel time. The benefits were greater access to desired destinations, yielding more opportunities and choices of employment, homes, services etc. However, the growth in distance travelled ceased in the mid-1990s.

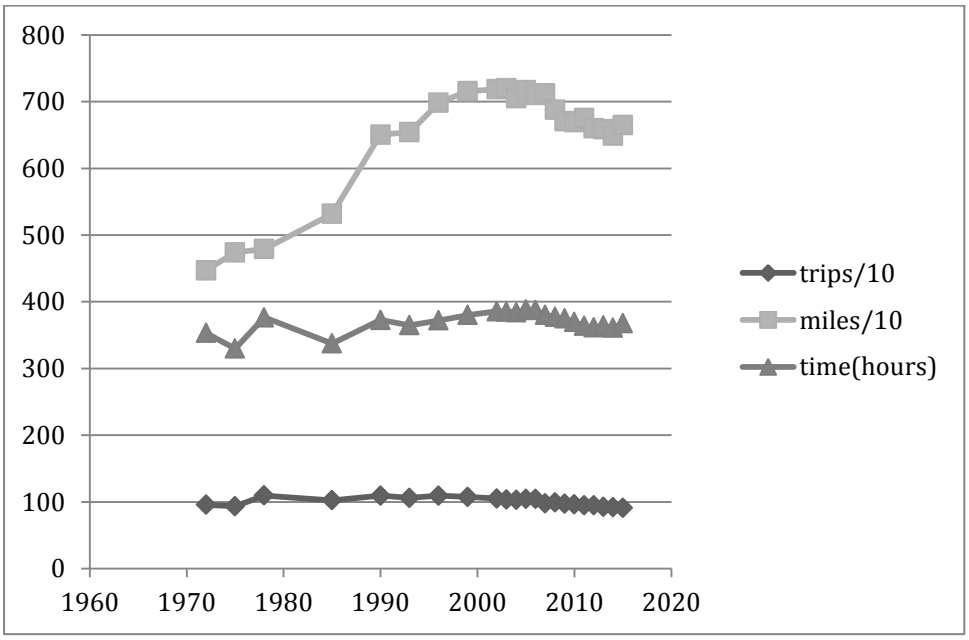


Figure 1. National Travel Survey, Table 00101

About three-quarters of the average distance travelled in Britain is by car, driver and passenger. Consistent with the NTS findings, average per capita distance travelled by car has stabilised, a phenomenon found for the developed counties generally and known as Peak Car. The contributory factors have been extensively analysed by Peter Jones and colleagues under the auspices of the Independent Transport Commission and other bodies, and do not need to be discussed here. There are, however, further factors contributing to the cessation of travel demand growth that are less well recognised.

## Demand saturation

In general, demand for a product or service cannot forever grow faster than the rate of growth of the economy as a whole. Growth must slow and then cease, described as 'market maturity' and 'demand saturation' (Metz 2013a). The distance travelled time series shown in Figure 1 is consistent with such a situation. Analysis of Department for Transport accessibility statistics and other sources indicates that people with use of a car or good public transport have high levels of choice of routinely used services: GPs, hospitals, schools, food stores and employment (Metz 2013b). For instance, 80% of the urban population of Britain have access to three or more large supermarkets within a 15 minute drive, and 60% to four or more, suggesting little incentive to travel further for greater choice and hence travel demand saturation for the purposes to travel to supermarkets (Metz 2010). This high level of choice has come about over the years through increasing car ownership, road improvements to make accessible edge of town locations, and the opening by the supermarket chains of additional stores, trends that have now largely played out.

However, not all journey purposes are subject to demand saturation. The main exception is commuting between home and work. There is in general a plentiful supply of housing accessible from where people work. However, affordability is a problem. Given price pressures in the housing market in many parts of the country, people take advantage of faster travel to seek more distant homes they can afford. An example is the popularity of London's Overground, a much improved inner orbital rail route that allows access to lower priced housing in locations previously seen as difficult to reach. Some of the largest percentage price increases in London housing were seen when the Overground allowed locations in inner southeast London to be accessed from employment in Docklands.

Demand saturation is also applicable to air travel. Figure 2 shows passenger numbers between the UK and USA and UK and Japan. In both cases, there was strong growth in the last century, which then ceased (US) or peaked (Japan). Detailed analysis of data from the International Passenger Survey shows a very substantial decline in inbound tourism from Japan, possibly reflecting an ageing population, a static economy and alternative holiday destinations. The rise and decline of tourism at particular destinations is nothing new: the English seaside resorts grew with the building of the railways and statutory paid holidays, and then declined as cheap air travel allowed Mediterranean resorts to be preferred.

Conventional forecasts of demand for air travel at UK airports project strong growth at least to mid-century. However, the evidence from the US and Japanese market segments, which are both substantial and well established, suggests that market maturity may be an emerging phenomenon which in time would be generally observed, raising a question about long term growth (Metz, 2016; Metz, Graham and Gordon, 2016). More generally, econometric models used for such forecasts presuppose substantial continuity between past and future and therefore do not display the behaviour seen in Figure 2.

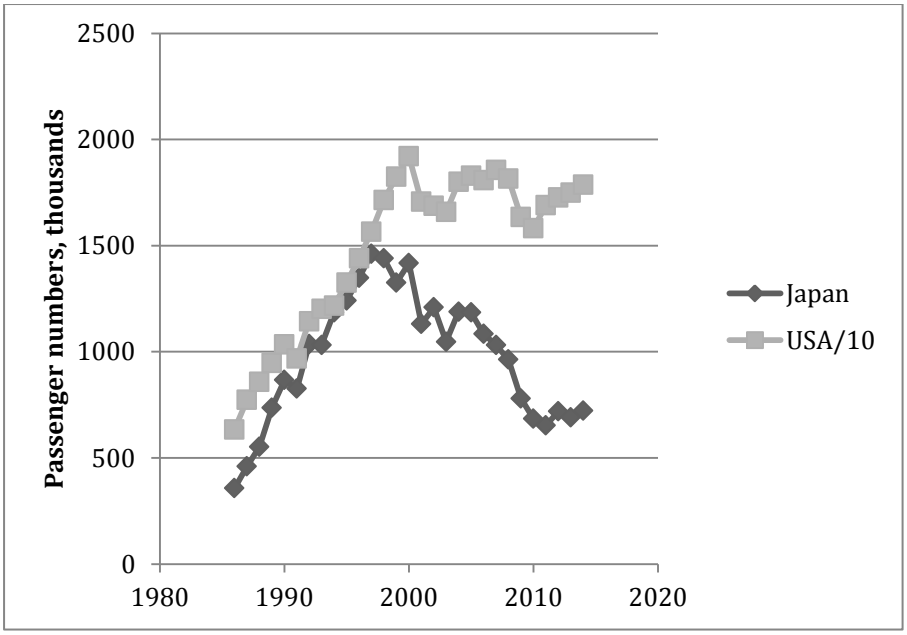


Figure 2. Annual passenger numbers between the UK and USA, and UK and Japan.

## Constraints on faster travel

A fundamental contributory factor to the cessation of growth of average distance travelled shown in Figure 1 is the difficulty of going faster. Cars cannot travel faster on uncongested roads safely and with acceptable emissions. The prospects for reducing congestion are poor, whether by road construction or in other ways. While car ownership per capita is still growing slowly, car use per capita is flat, implying that the increased availability is among those who drive relatively little. High-speed rail offers faster travel but only to a minority of rail users who are a minority of all travellers, hence little impact is expected on the average speed of travel. Driverless vehicles will not travel faster than conventional vehicles, although it is conceivable that the travel time constraint may be relaxed since such time could be more productive if not at the wheel.

The way in which traffic congestion constrains road travel is a key issue for travel demand, since demand of any kind is constrained by supply. Congestion occurs in populated areas with high levels of car ownership, such that many potential trips are suppressed by the prospect of delays in congested traffic. Congestion is unavoidable but self-limiting: as traffic builds up, speeds drop, and some drivers who are flexible make other choices of time, mode or destination. Congestion is difficult to mitigate on account of the suppressed trips. For instance, increasing the congestion charge in London would deter some existing users, but others for whom the charge is of less concern than the time delay would take their place – a kind of 'rebound effect'.

Road capacity constraints are a central cause of traffic congestion. Past attempts to relieve urban congestion by enlarging road capacity were disappointing, failing to reduce congestion on account of the extra traffic attracted and damaging the urban environment. Such 'improvements' are nowadays often

being unwound. On the other hand, attempts to reduce congestion by adding capacity remain in fashion for interurban roads. But we know from experience that we cannot build our way out of congestion, on account of the hitherto suppressed trips that emerge when capacity is added – 'induced traffic' – much of which is car commuting, as evidenced by the marked morning and evening traffic peaks seen on motorways and main roads in or near populated areas.

While road capacity constraints are a cause of traffic congestion, at the same time they inhibit growth of demand for car travel. Car traffic has not generally increased in the main UK cities over the past twenty years or more. In London, rapid population growth and capped car use mean that the share of journeys by car fell from a peak of 50% around 1990 to 36% currently. Figure 3 shows an estimate of the car's share of journeys in London over the century 1950-2050. The forward projection assumes continuity of policies to invest in rail but not to enlarge road capacity.

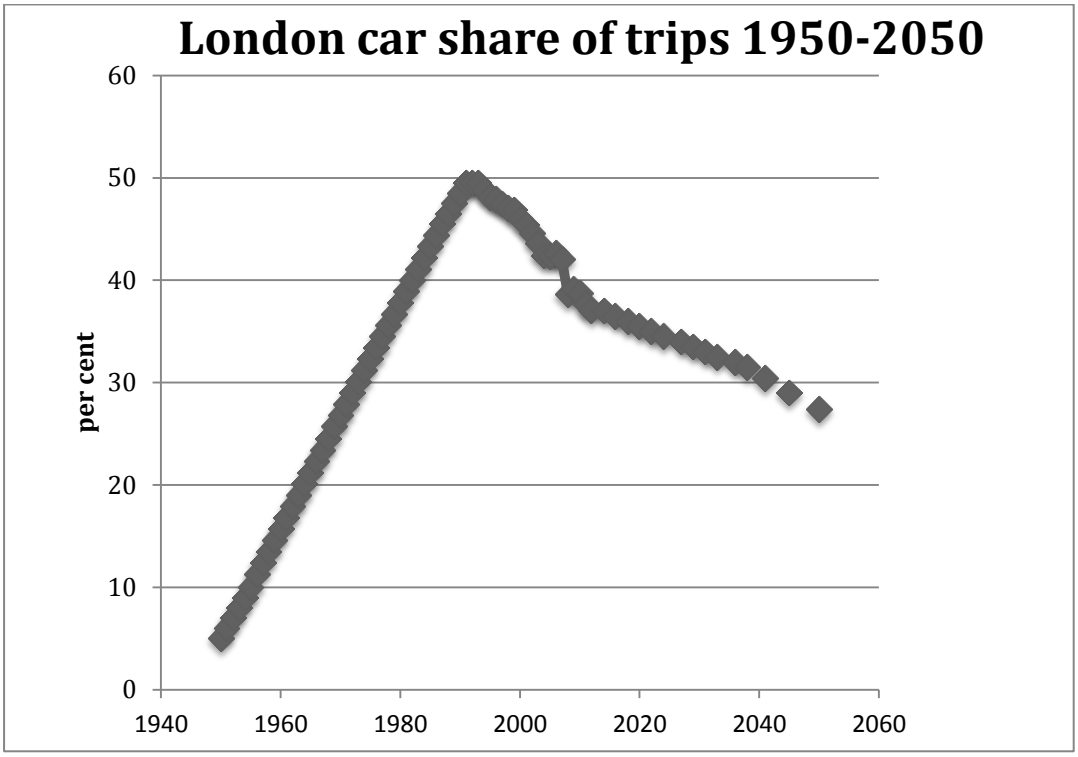


Figure 3. Car mode share in London 1950-2050, from Metz (2015).

The Department for Transport's National Transport Model projects car traffic growth in London of up to 37% by 2040, depending on scenario, with similar growth in other metropolitan areas. However, this is quite at odds with both historic trend and current policy. It appears that the model takes insufficient account of road capacity constraints.

## Behavioural change

The three Figures show breaks in trend of travel behaviour coinciding with the transition from the twentieth to the twenty-first centuries. Such behaviour was not predicted by conventional econometric models used to project future travel

demand, which assume substantial continuity between past and future, with historic elasticities broadly conserved and change driven by exogenous factors such as population growth, GDP growth and oil prices.

These breaks in trend indicate that travel behaviour may be more open to policy influence than is implied by conventional modelling. The challenge is to identify emerging trends and shape policies that take advantage of favourable changes in travel behaviour.

In practice, however, professionals invest so much effort in building models that they are reluctant to recognise behavioural changes that are inconsistent with their models. Indeed, they commonly fail to recognise the significance of new evidence. The peak of car mode share in London shown in Figure 3 happening 25 years ago, yet the DfT modellers responsible for the National Transport Model remain in denial about Peak Car.

While travel behaviours change, a long-term invariant is average travel time, which has remained at about an hour a day for settled human populations probably since humans ceased to be foragers and established farming communities. In the past, investments and interventions that allow higher speeds result in greater distances travelled. Conversely, interventions that reduce speed lead to smaller distances traversed, with a loss of opportunities and choices, which is a reason for the limited impact of measures aimed at getting people out of their cars.

We are now in an era in which average per capita travel behaviour has stabilised and seems unlikely to grow in the future. So total travel demand will be driven by population growth. The pattern of demand will depend on where the additional inhabitants are housed: to the extent on greenfield sites, then they would acquire cars and investment in roads would be needed. But to the extent that population growth occurs in cities, investment in public transport would be required. The spatial context is therefore important when addressing the likely future growth of travel demand.

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6 February 2017

**DfT Submission to the Commission on Travel Demand**

**Summary**


- In recent years we have observed significant changes in travel demand trends. The total distance travelled by car levelled off between 2007 and 2013 after years of growth, though it has risen again since 2014. Meanwhile over recent decades aggregate van traffic has grown steeply, while HGV traffic has been fairly flat. After many years of declining rail patronage, rail demand has also grown strongly since 1994/1995.
- The Department for Transport (DfT) has been active in working to understand the underlying drivers of these trends in aggregate traffic: undertaking and commissioning research, engaging with stakeholders and the wider academic community and bringing together evidence to inform our modelling and appraisal frameworks.
- This work has suggested that there are diverse factors underlying these trends, some of which are better understood than others. People's travel behaviour has become more complex and less uniform. Evidence suggests varying changes in travel behaviour across different sectors of the population with young people and men generally travelling less than previously, while women and older people drive more. This has been driven by social change: activities associated with wellbeing rather than economic growth – such as visiting friends and family – have become more important in driving travel demand; trip chaining has increased; and single purpose home-to-workplace trips have declined.
- As we look to the future, not only do we need to try and understand how those trends in travel behaviour may develop further, but new and rapidly emerging technologies such as connected and autonomous vehicles will also have an impact on travel demand.
- Recent research and evidence reviews in this area suggest that key drivers of transport demand, including population, GDP growth and employment, are still some of the most relevant drivers and these are well-represented in core DfT forecasting models. Where there remains uncertainty about how those drivers will evolve over time, we consider how best to represent this in our forecasts, including through increasing use of scenarios to reflect plausible alternative futures.
- The most recent updates to DfT's evidence base discussed below will be summarised in a forthcoming UVITI Progress Report.

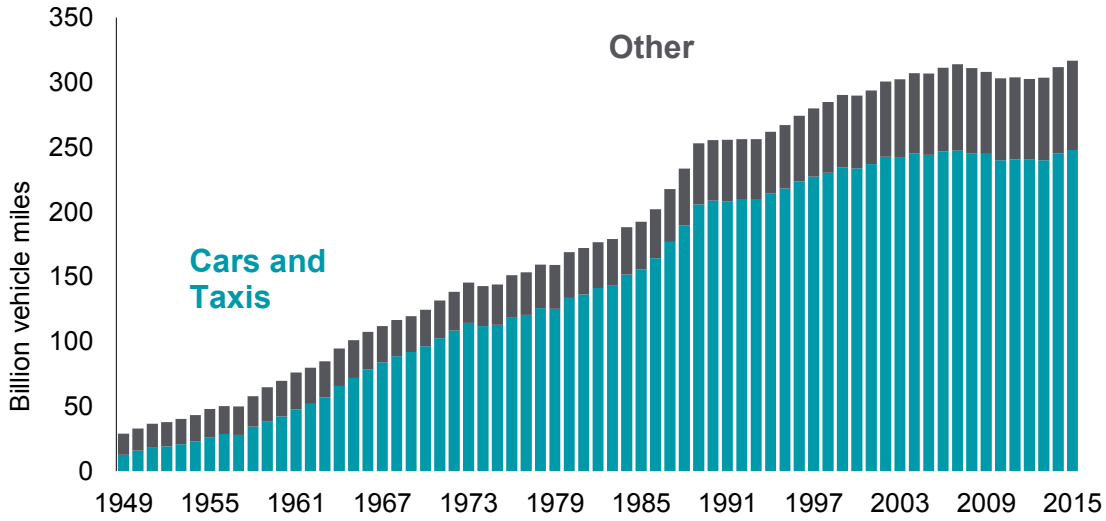
**Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?**

***Observed trends in aggregate travel demand***

1. Recent trends in aggregate road travel demand were summarised in Understanding the Drivers of Road Travel[1] and include:
   - The overall rate of growth in road traffic has slowed over time.
   - There was a levelling off of car travel at aggregate level between 2007 and 2013 (see Figure 1) though, since 2014, growth has returned.
   - There has been significant sustained growth in LGV mileage over the last 30 years, while HGV mileage has remained broadly flat over a similar period.
   - Walking trips per person have declined by almost a third in the last twenty years, although the average distance per trip has increased: this has led to a decline in total distance walked. The number of cycling trips has remained broadly constant but average trip length has increased as has the average distance cycled per person[2].

**Figure 1: Total distance travelled by cars and taxis, and other motor vehicles 1949-2015**

*Source: National Road Traffic Survey, Department for Transport*




2. Meanwhile, observed trends across non-road modes include:
   - Over the past 20 years, rail journeys have more than doubled, with strong growth even through the recent recession. There has also been strong growth in rail demand across cities in the North.
   - Aviation has seen fast growth, but with a downturn during the recession.

[1] Understanding the Drivers of Road Travel, DfT (2015)
[2] DfT Road Use Statistics (2016), https://www.gov.uk/government/statistics/road-use-statistics-2016

***Drivers of travel demand***

3. DfT has been actively working to understand the key drivers of the observed trends in aggregate traffic levels summarised above. National Travel Survey (NTS) data has provided some indication of shifts in underlying behaviour which are driving these trends, including changes in trip rates over time, by trip purpose and by mode. Early research into trip-making behaviour was summarised in the 2014 UVITI Progress Report[3] and more recent research on trip rates has been incorporated into DfT's National Trip End Model.

4. To better understand the factors which underlie the observed changes in both aggregate travel demand and individual behaviour DfT has undertaken several pieces of further research. This includes the work on Understanding the Drivers of Road Travel as well as research targeted at understanding the travel behaviour of specific groups such as young people and trends in commuting. In addition, we have carried out analysis to quantify the impact of different factors (e.g. age, employment status, location) on car travel and to develop a better understanding of the factors behind the decline in individual (average) car use over time. Finally research has also been undertaken to understand whether new rail demand drivers should be incorporated in rail forecasting models.

***Efficacy of traditional forecasting approaches***

5. Recent evidence[4] commissioned by DfT suggests that the traditional drivers of travel demand continue to play an important role in determining observed levels of road, rail and air traffic. These include the key economic drivers: income (GDP) and fuel costs, as well as population, where a review of evidence across recent studies suggest that traditional relationships continue to hold.

6. Analysis of previous transport forecasts at an aggregate level suggests that where demand has been over-forecast, this is substantially attributable to over-forecasts in key inputs to the model rather than modelling error. When outturn data on drivers such as GDP growth and fuel costs are incorporated in transport models, the models are more effective at estimating outturn traffic. This leads us to believe that transport demand is, and will continue to be, explained by these key drivers to a reasonable extent.

7. DfT transport forecasts are underpinned by a forecast of future travel demand produced by the National Trip End Model (NTEM). The model takes as inputs detailed forecasts of population growth, employment and housing supply, as well as

[3] Understanding and Valuing the Impacts of Transport Investment (UVITI), Progress Report 2014, DfT (2014), https://www.gov.uk/government/publications/transport-appraisal-in-investment-decisions-understanding-and-valuing-the-impacts-of-transport-investment

[4] Road traffic demand elasticities, a rapid evidence assessment, RAND Europe for DfT, December 2014

NTS data on trip rates and journey purpose to forecast future trip ends. While NTEM draws on years of research and evidence, the Department recognises the need to keep the input assumptions under review to ensure forecasts reflect key drivers of travel behaviour.

8. For rail, forecasts for the recession period did not predict the strong growth in demand we saw. This suggested that the relationship between the traditional drivers of demand (rail fares, car cost, GDP growth and employment) and rail demand may have changed. Research in this area has focused on looking at how employment broken down by sector and occupation can have different impacts on rail demand.

**How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain the change?**

9. Understanding the Drivers of Road Travel (2015) explored factors affecting road travel, as well as identifying areas of uncertainty around the levelling off of road traffic growth, market saturation for car travel, and changes to young people's travel behaviour. The Department has conducted an econometric analysis quantifying the impact of some of those factors on car travel demand.

10. The analysis uses NTS data to examine the factors that influence licence holding, car access and mileage, which collectively determine an individual's car travel demand. The analysis finds that the probability of licence holding and car access are strongly impacted by income related factors (employment type, occupational status, and income), age, location (urban vs rural), household structure and gender. Mileage is also affected by these factors, though to a lesser extent, hence it is a more stable statistic than licence holding and car access.

11. The econometric work also examined changes in the impact of each factor over time. Most factors have remained stable between 1995 and 2014, though the relationship between income and car travel has weakened. The manner in which this relationship will change in the future is uncertain.

***Changes in young people's travel behaviours (particularly car use)***

12. The econometric work supported the trends found in Understanding the Drivers of Road Travel relating to younger people. Using cohort variables, the report finds that the more recent a cohort that a person was born in, the greater the downward impact is upon mileage. This is most noticeable for those born in the 1970s onwards.

13. To explore this trend further, DfT has commissioned research to explore the links between social change and changing patterns in young people's travel behaviour. Factors covered in the analysis include the decline in private home ownership and re-urbanisation; employment related factors, such as the rise of precarious work and a decline in disposable income; costs of transport, such as fuel and insurance costs;

and the impact of attitudinal changes, such as more pro-environmental attitudes and a decline in the car as a status symbol.

***Implications of an ageing population***

14. Older people have different transport needs, partly because they are far more likely to have mobility issues and evidence shows that people with disabilities have different travel behaviours[5]. Older people are also much more likely to live in rural areas[6].

15. Older people mostly travel by car, either as a driver or a passenger, with more people aged 70 and over holding a driving licence than previously. Location helps to explain why as people age they become more car dependent.

16. In future, people are also expected to work for longer and this will have an impact on commuting trends, particularly if many of them live outside cities and are reliant on cars for part or all of the journey.

***Changes to commuting patterns***

17. The Department has commissioned research into the decline in commuting trips[7]. The report drew on a number of datasets, anchored by the National Travel Survey, finding that the relative decline in commuting trips has been greater than the decline in overall trips, with commuting trips falling from 7.1 journeys per worker per week in 1988/92 to 5.7 journeys per worker per week in 2013/14.

18. The report reports that there has been an increase in trip chaining, in which a person makes intermediate stops within a single trip, leading to a decline in traditional home-work commutes, as well as a rise in respondents to the NTS who do not report a fixed usual workplace. These changes mean that these journeys are not classified as 'commutes' in the NTS and hence some commuting-type trips are no longer captured in data. The report raises the question of whether the NTS definition is therefore too narrow.

19. In addition, whilst the average working day is longer, the overall working week has decreased in hourly terms; consequently, fewer people commute on 6 or more days. Working from home has also increased. Working from home is meant in the sense of increased provision for working outside of a usual workplace, and also a growing number of workers finding employment that does not require them to commute in a traditional sense.

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[5] See summary in Disability and Travel Factsheet 2007-2014 (DfT, 2014), https://www.gov.uk/government/publications/nts-factsheets

[6] https://www.gov.uk/government/publications/rural-population-and-migration/rural-population-201415

[7] LeVine S., Polak J., Humphrey A., Commuting Trends in England (forthcoming)

***Potential impact of emerging technologies on travel behaviour***

20. DfT is actively involved in considering how trends in travel behaviour may evolve over time, and as part of this is considering how emerging technologies such as connected and autonomous vehicles will impact on future travel demand.

21. The bulk of research carried out to date on Autonomous Vehicles (AVs) has a strong focus on technology driving changes and often talks of AVs becoming commonplace within a relatively short time period, with the assumption that any social concerns or behavioural issues will be readily ameliorated, if/when they arise. In contrast, a scoping study commissioned by the Department found that many stakeholders believe that social and behavioural issues are of central importance and may in turn influence the development and take-up of the technology. [8]

22. Changes in working patterns may allow services such as Mobility as a Service (MaaS) to take root with the potential to impact on travel demand. Although there remain barriers to a widespread move to MaaS (e.g. around consumer and data protection, and interoperability) there is the potential for MaaS to blur the perceived differences between public and private transport vehicle use and increased relevance to consumers of the 'access over ownership' models. This could lead to a reduction in single occupancy vehicle use with a knock-on effect on travel demand.

23. Finally, an emerging area of work is Smart Cities[9] looking at the impact of technology on transport, energy and data, and what this means for cities of the future. The challenge for DfT and other departments will be to build on and incorporate this into our long-term planning for transport policy in cities, for example ensuring that any negative consequences on the environment associated with promoting vehicle usage over public transport are mitigated.

**How do these vary spatially? Are there distinctions between central, suburban and rural areas and are there differences between cities?**

24. Understanding the Drivers of Road Transport identified variations in traffic growth across road types, with growth in traffic on the strategic road network (SRN) and on rural roads, but with traffic on urban roads levelling off over time.

25. DfT's understanding of the spatial variations in travel demand has also been informed by the car travel econometric work which finds that as the degree of urbanisation increases the likelihood of holding a licence and having access to a car decreases and has a downward impact upon mileage. This analysis also considered

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/585545/social-and-behavioural-questions-associated-with-automated-vehicles-final-report.pdf

[9] Smart cities are enhanced city systems which use data and technology to monitor, manage and improve key infrastructure and transport services for citizens

how the factors influencing car travel vary by region, finding that the factors are broadly consistent across different regions, with the exception of occupation type.

26. Whilst the Commuting Trends in England report did not give substantial attention to spatial differentiation, it did note that commutes are of a longer duration and shorter distance in urbanised areas, especially London.

**How do they vary over time? Are there particular times in the week where demand has changed or seasonal variations which have emerged?**

27. The *Commuting Trends in England* report documents that work-home trips have become more concentrated within a shorter period in the afternoon, though there is no such trend for home-work journeys in the morning. The report also explores the difference between term time and school holidays, finding that part time workers are three times more likely than full time workers to make escort journeys during term time.

**What methods can be used to incorporate greater uncertainty in demand? Have they been deployed and to what effect?**

28. When forecasting demand over 30 or more years, considerable uncertainties arise. Traditionally, the Department has incorporated uncertainty analysis in its forecasts by considering high-low sensitivities around assumptions on core economic drivers such as GDP growth and fuel prices.

29. Our latest thinking on the treatment of uncertainty is set out in the forthcoming UVITI progress report and covers the following areas:

    - Capturing uncertainty in the key building blocks of modelling and appraisal
    - Developing our understanding of our forecasting capability through ex-post evaluation
    - Enhancing the approach to modelling benefits in the long term; and
    - Communicating uncertainty to decision makers through different technical methods such as scenario analysis

30. Scenario analysis was incorporated into our published National Road Traffic Forecasts in 2015 and the Department continues to explore how best to use scenarios to present uncertainty in policy making. The use of scenarios will allow us to explore both uncertainties around key drivers such as trends in trip rates, as well as taking account of the uncertainty posed by emerging technologies such as connected and autonomous vehicles.

31. Additional options for future scenario analysis will be developed in the Future of Mobility Foresight study, to be completed by Government Office for Science by summer 2018. The study will examine the technological, demographic, behavioural, environmental and other trends that will affect mobility out to 2040, and provide new types of scenario against which policy options can be tested.

**Conclusion**

DfT welcomes the work of the Commission on Travel Demand and we are pleased to provide this submission summarising evidence from our recent research in this area, which has provided considerable insight into the key drivers of travel demand which underpin trends observed in aggregate data. DfT is committed to continuing work in this area and to developing a better understanding of the uncertainty around key drivers. We look forward to continuing to engage with experts and stakeholders as we do this, including with the Commission.

# COMMISSION ON TRAVEL DEMAND

# CALL FOR EVIDENCE: UNDERSTANDING CHANGING TRAVEL DEMAND

## Response by the Freight Traffic Control 2050 project partners (www.ftc2050.com)

## Changing logistics patterns and the implications for travel demand

### *Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?*

**On-line shopping is growing at around 10-12% per annum generating more small van trips and is being fuelled by**:

- New demand: An ageing of the population
- Older people discover the convenience of internet ordering
- Young people used to internet and remote ordering by the internet (42% of 18-25 year olds use e-retail as their preferred medium)
- Traditional shopping (bricks and mortar) is hit by the economic downturn and the competition of online shopping: number of shops reduce
- Certain goods, such as groceries which only have a small relative online presence, will increase, considering the above mentioned factors
- The use of smart phones to purchase goods online will continue to grow making shopping at home and on the move more convenient and easier

**We are demanding speedier home delivery of goods and services which is fuelling less efficient van use and leading to a growth in lifestyle couriers**:

- 74% of online retailers offer next day delivery services, while only 4% offer same day deliveries (the latter is increasing however).
- Nominated delivery time slots are offered by around 18% of retailers, and Saturday delivery by 35% (Oracle, 2016).
- In the last couple of years several major online retailers have introduced what are referred to as 'delivery passes'. These are membership schemes that provide members with 'free' home deliveries. Members have to pay either a monthly or annual subscription for their delivery pass, and often, in the case of grocers, still have to spend a minimum amount to qualify for free home delivery. Annual subscription fees typically range from £60-80 per retailer but fuel the misconception that delivery is typically next-day and 'free' (Allen et al., 2017).

**More dedicated trips are being made by consignees to collect packages they have missed first-time:**

- It has been estimated that in total 13-14% of all e-commerce deliveries in the UK arrive either late or when the customer is not at home (IMRG, 2014a).
- The IMRG has estimated that in 2014, the cost of these 'failed' deliveries to retailers and other traders for goods sold online in the UK was £771 million (IMRG, 2014b).

- The various systems of home delivery (delivery to homes by vans, click and collect / collection points, and locker banks)

**Passenger trips are becoming an intrinsic part of the supply chain**

- Inefficient use of cars for freight (e.g. from click-and-collect/unattended locker to home) which suits retailers / carriers as it makes delivery systems more efficient and cheaper (allowing bigger loads to be delivered to a single point whereas deliveries to individual homes involves small transactions to many locations). Online sales that made use of Click & Collect services in 2016 accounted for 11% of total online sales, and 25% of all online clothing and footwear sales (Verdict, 2016a).
- Crowdshipping involves, 'enlisting people who are already travelling from points A to B to take a package along with them, making a stop along the way to drop it off' (US Postal Service, 2014). It therefore makes use of members of the public who are making journeys to act as couriers for the distribution of parcels and other small items, thereby creating new informal logistics networks. Such services have emerged over approximately the last five years, and have recently expanded to include journeys made especially to deliver a package, largely precipitated by the entry of UberRUSH into the marketplace (McKinnon, 2016). Crowdshipping is provided via crowdshipping online platforms such as Postmates, Zipments, Deliv, Roadie (In America, where there are currently more crowdshipping services than anywhere else), PostRope (Australia), Renren Kuaidi (China), Nimber (Norway), Trunkrs (Netherlands), and PiggyBaggy (Finland) (McKinnon, 2016).
- Such a model would be likely to reduce delivery costs and transit times, making same day delivery potentially more financially and operationally viable, and may provide online retailing with the lower cost operating model it requires to become more profitable. This would be an extension of the agent-based final-leg home delivery services used by major home shopping retailers for many decades. Such a future would involve crowdshipping replacing much of the existing model used by the parcels industry in urban areas involving employed staff using company-owned vehicles.
- If the growth in supply of crowdshipping permits ever-cheaper, ever-faster last-mile delivery services then this could permit a substantial growth in the demand for rapid response online retailing and hence ever-greater total traffic activity in urban areas.

**The desire for convenience and the lack of time is fuelling the growth in food home delivery:**

- Over time, it is likely that this desire for convenience will result in ever-greater levels of home delivery of groceries, prepared ingredients/recipes and ready-to-eat meals, which will erode the dominance of traditional store-based grocery retailers (Mignot, 2015).
- It has been estimated that the UK takeaway and other restaurant home-delivered food market was worth approximately £6.7 billion in 2015, up from £4.4 billion four years ago (Fedor, 2016; Martin, 2016). This is forecast to increase to £7.6 billion by 2020 (Euromonitor International quoted in Ruddick, 2015).
- Whilst individual restaurants and restaurant chains have been expanding their home delivery services in a gradual manner, most of the growth in the market has resulted from the launch of third-party service providers, who offer meal deliveries from

multiple restaurants. These third-party providers are intermediaries between the restaurant and customer and vary in terms of the services they provide to restaurants.
- There has been substantial investment in the takeaway and home-delivered meal market in the last few years. It has been estimated that nearly $10 billion (8.9 billion euros) was invested into 421 meal delivery deals since the start of 2014 according to research from CBInsights (quoted in Auchard, 2016).
- Deliveroo launched its meal home delivery service in the UK 2013. It currently operates in 81 cities globally, working with 15,000 restaurants that wouldn't otherwise offer deliver including Pizza Express, Prezzo and Gourmet Burger Kitchen. Deliveroo's daily orders have grown tenfold since January 2015 (Tugby, 2016).

## *How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain change?*

- Trip generation resulting from new click-and-collect / collection point activity involves goods vehicles and cars. The wider traffic impacts related to the timing of these trips is not well understood.
- Increased deliveries to homes leads to new trip generation in residential areas, and associated parking, congestion and safety issues.
- Failed deliveries at home have led to an increase in personal deliveries to workplaces which results in trip generation in central urban areas putting pressure on post rooms in buildings. Some companies and organisations are starting to impose bans to discourage employees from diverting deliveries.
- More time-dependent deliveries has led to the need for logistics fulfilment centres in urban areas – new types of warehouses with different trip generation rates and vehicle types compared to traditional warehousing.
- The emphasis on walking, cycling and public transport has led to more bus lanes and cycle lanes in our cities. This has led to kerbside access issues for freight vehicles and a lack of/ insufficient loading/unloading space which can lead to un necessary mileage with circulating vehicles looking for somewhere to stop. Drivers also use 'hoteling' where 70% of the round can be on-foot, using the vehicle as a mini-warehouse and replenishment centre as part fo a multi-drop round. Having to return to locations later in multi-drop rounds can lead to double parking and waiting causing knock-on traffic impacts.

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# AGE AND GENERATIONAL EFFECTS IN TRAVEL BEHAVIOUR – GORDON STOKES *(Visiting Research Associate, Transport Studies Unit, University of Oxford)*

*There is a large element of 'habit' in lifelong access to a car. This submission suggests that age cohorts will continue to use cars in ways they have learnt up to the age of 40. Forecasts should not assume that those in their 20, 30s and 40s who are using cars less will ever use them much more than they do. But it's more difficult to predict what those under 17 and those not yet born will do.*

Based on NTS England data from 1985 to 2014 it notes that different generations have travelled differently, mainly in terms of their car use, and that car travel habits formed in younger years generally 'stick'. This note is a reduced version of http://gordonstokes.co.uk/travbeh/agegen.html and mainly addresses Question 1 of the call. For Q3, material mapping census travel to work data may be of use, but is not discussed here - http://gordonstokes.co.uk/travcen/censusflows.html - and - http://gordonstokes.co.uk/travmap/testmaps.html .

## 1. CHANGE IN TRAVEL BEHAVIOUR IN RELATION TO LIFE COURSE

The ages between about 10 and 20 and then from about 60 onwards are key in terms of travel behaviour change. This covers the period of 'life changes' from primary to secondary school, then through to work and established families (for most people) - and from retirement onwards. During teenage years independent travel becomes the norm. From 17 driving becomes a possibility and is taken up by many. Various factors will affect how many do drive, and how much they drive, but patterns tend to be set in early adulthood, and are then less likely to change.

## 2. CHANGES IN THE USE OF VARIOUS MODES OVER TIME FOR DIFFERENT AGES

Walking has declined for most age and sex groups over time. The falls have generally been greater in older age for men, and in middle age for women. Bus use has not changed significantly for many age groups, but has fallen in teenage years, especially for women. Free bus travel has not had a major impact of increasing likelihood of using a bus in later years. Rail use has been rising since around 1995 for most age/ gender groups, but while men seemed to show an increase between 1995-99 and 2000-04 the increase for women only seemed to take off after the 2000-04 period.

Car driving by age has shown quite remarkable changes for both sexes, and these changes are of a very different nature to bus, rail and walk. While for most modes any increase or reduction has been relatively uniform across ages, the pattern for driving shows some age groups increasing use while others reduce, and the changes seem to follow generational patterns.

Driving my men remains high well into old age, compared with women. While men use driving more than any other mode up to their 80s, walking is more common for women from the mid-60s. BUT rather than differences in 'taste', historical gender differences in propensity to learn to drive and run cars in past decades explains this.

For men a graph of access to a car as a main driver by age (Figure 1) looks like a wave moving forward, and that is a good description of what has happened. In the late 1990s a driving trip was made by about 80% of males up to the age of about 55 and then dropped off for older people. In 1997 (mid-point of that period) those people would have been born in the 1940s, including the baby boom period and it was this generation who learnt to drive and acquire cars in large numbers.

By 2010-14 the age of this level of 80% use had risen to 70 implying that the same generation were still as likely to drive as they were 15 years earlier.

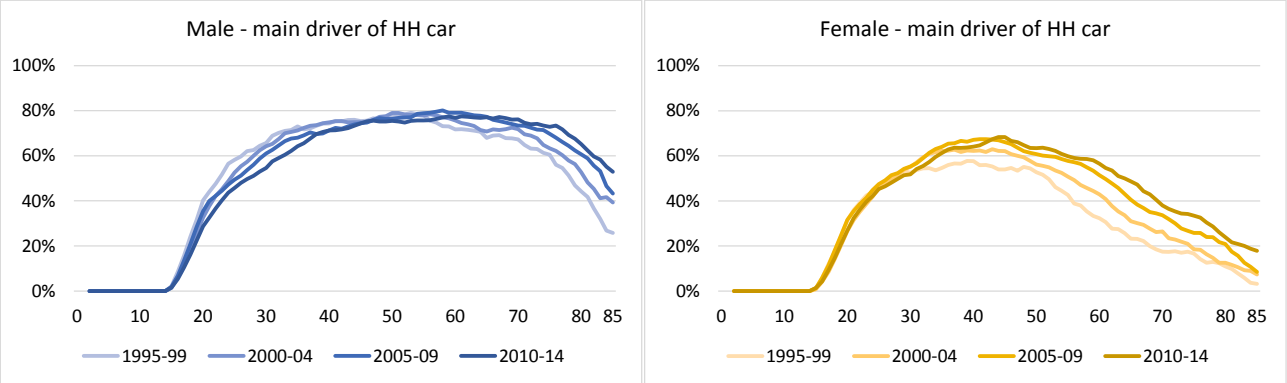


*Figure 1 - % with access to a car as a main driver 1995-9 to 2010-14 (NTS data)*

At the younger end of the male chart the picture is different. The ‘slope’ upwards to a high level of likelihood of driving started rapidly in 1995-99 but by 2010-14 showed a similar start at age 17-19, but then slows much more. Whereas in 1995-99 around 80% were driving by age 30, this level wasn't reached till age 45 by 2010-14. Becoming a regular car driver has become less likely for the generations born after about the mid-1960s.

For women there are elements of the same trends, but in the 1960s women were still much less likely to learn to drive and acquire cars. For them the rise in car use came later, and the overall wave has got bigger.

## 3. Possible reasons for changes

There are many explanations for these changes, but the most plausible ones relate to the situations generations were brought up in and what we might call 'habit'. Ideas include:-

- Men born in the 1940s, and 50s grew up at a time when cars were seen as ‘the future’, gaining a driving licence and car was a sort of ‘rite of passage’ into adulthood, and driving was ‘fun’. Men's propensity to drive may well have been greater than the utility offered.
- Men born from about 1970 onwards grew up belted in a car with less independent travel, when congestion was increasing. ‘Motoring’ was less enthralling than for the older generation. They were very much more likely to go to university or college, in big cities where having a car was not an advantage, or where cars were restricted. If anything was replacing the car as a status symbol it was technology - computer games and, more recently, smart phones. The cost of insurance for younger drivers increased rapidly, and the driving test became more complex. People accepted that drinking and driving was, to say the least, unwise. In recent years student debt, high youth unemployment rates (or ‘zero hours contract’ type work) combined with worsening housing affordability has placed financial strain on many people aged up to about 35.
- For women the historical situation was different. Up to those born in the 1940s driving was often seen as a 'male' activity, and few learnt to drive. But with increasing gender equality and working rates the practical advantages of driving became apparent. Driving amongst younger women increased. Since around 2010 the likelihood of men and women being the main driver of a car has reached 'equality' up to the age of about 40.

- Older women were less likely to have ever got a driving licence or a car. Few people gain a licence after about the age of 30 (see below). So we are left with an older generation of women who are never likely to drive. In the 1990s this meant that women over the age of 50 were much less likely to drive but by the 2010s this age has reached nearer 70.

Once people have access to a car they tend to not give it up. Cars are useful (for most people in most situations) and few people voluntarily decide that they might as well do without. It is usually ill health that stops people driving. Added to this, NTS data shows many more elderly people report having difficulty walking or using public transport than using a car - driving is easier on a failing body than walking to a bus stop. This is compounded by facilities getting larger and more distant from home, with bus services are under threat in many areas.

4. HOW HAVE COHORTS/ GENERATIONS CHANGE OVER TIME?

Figure 2 follow each age cohort in terms of how they use a mode throughout the survey years. Each line in the chart is a trajectory of how a cohort (or generation born at a set time) changed their travel behaviour between different survey times from 1985-9 to 2010-14. The early years (from 1985) have to be treated with caution, since uniform weighting of NTS data is only available from 1995. But with a simple measure of whether or not people used a travel mode, it is felt that as long as the graphs are taken as 'pictorial', they provide more insight than omitting them.

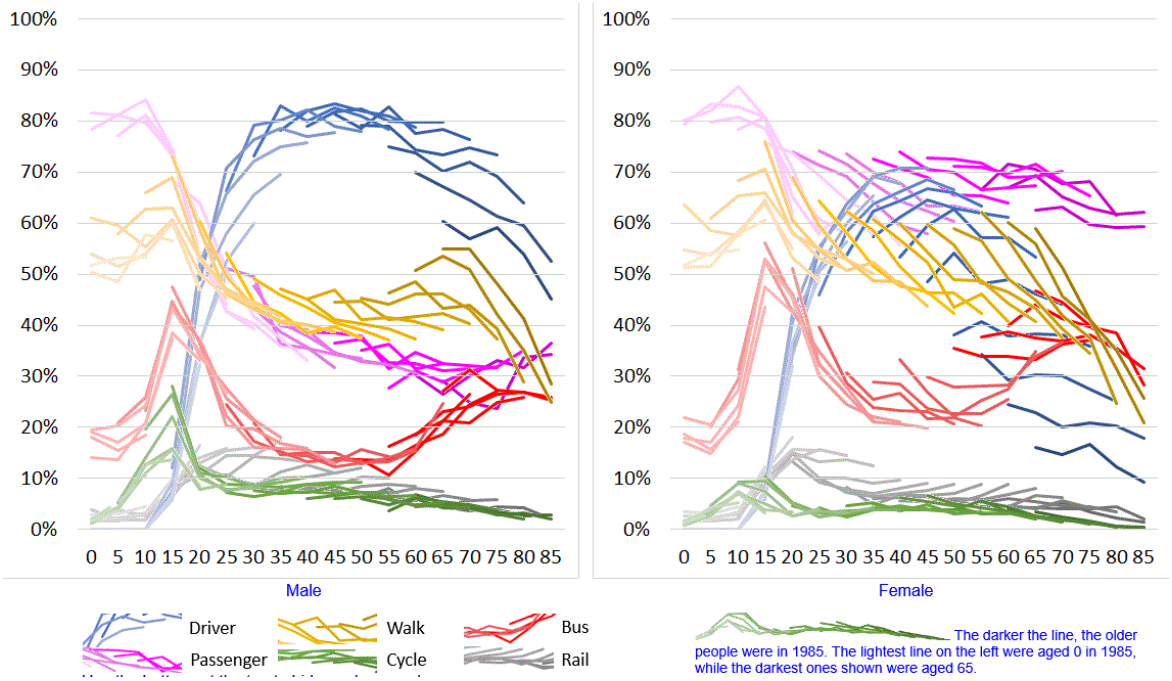


*Figure 2 – How cohorts have changed their use of modes between 1985 and 2014 (NTS data)*

HTTP://GORDONSTOKES.CO.UK/TRAVDYN/COHORTMIX.HTML shows a version where modes can be selected

Driving (blue lines) for men:-

- In middle age, likelihood of driving remains fairly steady while in older age the likelihood does reduce.
- For all younger age groups the likelihood grows, but tracking up vertically for those aged, say, 30, it's apparent that those born in 1980 are less likely to drive than those born in 1970. By age 30, 72% of males born in 1970 were driving, while only 60% of those born in 1980

were. At age 70, 57% of males born in 1920 were driving, but 72% of those born in 1930 were.

Driving for women:-

- Older women seem just as likely to have carried on driving over the survey periods. Only for those born in 1930 and earlier was there a significant fall, and this was much less than for men. This may relate to living longer than men.
- The distance between the parallel lines from about age 40 onwards (in 1985) points to the increasing likelihood of driving for those born up to about 1970. For men these lines only diverge from about age 60 (in 1985)
- The trajectories in younger life are relatively similar for men and women.

The charts for travelling as a *car passenger* very roughly mirror the charts for driving (in terms of being opposite). The male chart then dives much lower to around 30% in mid-life years, while the female reduces much less. Women from the age of 20 to about 50 to 60 show a trend towards much less likelihood of being a passenger over time. While, around 1985, about 74% of women aged 30 travelled as a passenger, by 2010-14 the figure was around 58%.

*Walk* journeys have fallen for just about all cohorts of different ages. The only exceptions are for young children, who are at a stage of life when we would expect increasing likelihood of walk trips. While falls from age 20 to age 35 might be regarded by some as an inevitable consequence of a move from 'youth' to a busier lifestyle, the consistent falls for other ages are almost shocking.

*Bus* generally shows less generational cohort change. The lines for men follow roughly the same trajectories by age. For women, however, there has been a 'level' use of bus by those born from about 1935 to 1945, but with each cohort starting from a lower rate. For *rail* the rates are low, but the growth in patronage that has occurred since 1995 can be seen to have been strongest amongst those of working age. Unlike any of the other modes most cohorts are increasing their likelihood of travelling by train.

So 'habit' is observable in NTS travel data for driving, but much less so for other modes. This raises the question of whether there is something in car use that encourages habitual behaviour (e.g. it's 'too convenient' to stop or reduce car use) or whether other modes have not yet gained a 'lifetime' habit status. Cycling is a mode that many see as a 'lifestyle', but few would say the same about buses. Rail doesn't serve enough journey needs to be a lifestyle choice.

## 5. CAN WE PREDICT WHAT WILL HAPPEN TO THE GENERATION WHO ARE DRIVING LESS IN THEIR YOUTH?

*Accurate forecasting is never possible, or maybe even sensible or desirable. The best forecast is more likely to be wrong than right, and lead to wrong decisions, and, at worst, accusations such as "we don't need experts". Far more important is to formulate a plan that is robust to the range of plausible and likely futures that we can identify. If you take one thing away from this submission, I hope that will be it.*

The slowdown in younger people acquiring licences and cars begs the question of whether they will do so at some point in the future. Some argue that when people have families, gain wealth, and likely move from cities to small towns and rural areas, they will acquire cars. Others argue that once

younger people are in the habit of not using cars they will tend to steer life so they don't need a car. Of course, some will get cars, some won't - the question is 'how many'?

Current evidence based on past behaviour points to a reduced likelihood of gaining a licence in later life, and that those who acquire a licence later in left tend to drive less – Figures 3 and 4.

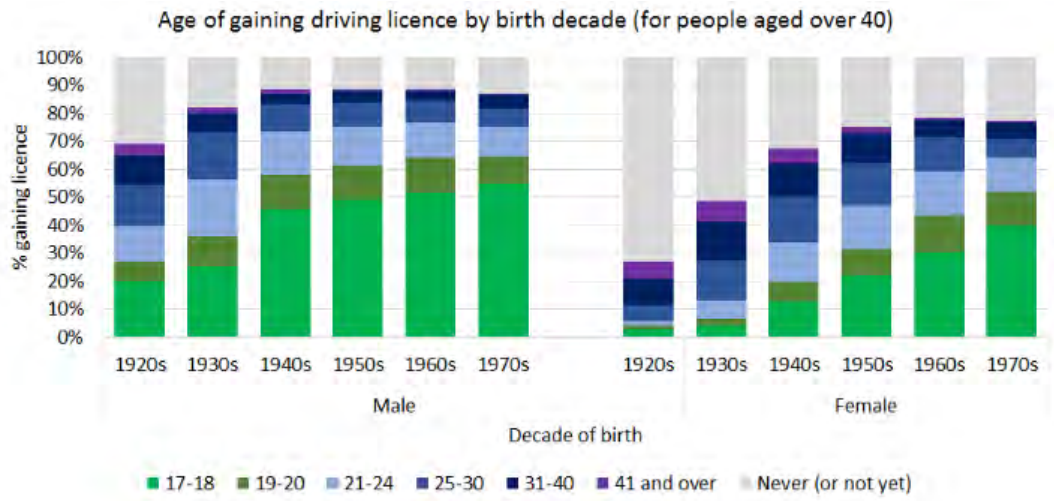


*Figure 3 – Age at which licences were gained by decade of birth (NTS data)*

In generations in which most people drive, most get a licence when quite young. For men born since the 1950s, by the age of 40 and over, around 85% have a full licence, and over half of these gained their licence aged 17 or 18. The proportion gaining a licence after the age of 30 is very small (around 5%). For women the situation is somewhat different, with many more born in the 1940s and 1950s getting a licence later, but still less than 15% getting one after the age of 30. By the time of those born in the 1970s the profiles look very similar to that for men.

A question in past NTS surveys implied that many without licences intended to get one within the next one or five years. However, there is often a difference between intention and action. An interviewer asking such a question is likely to encourage a 'positive' answer.

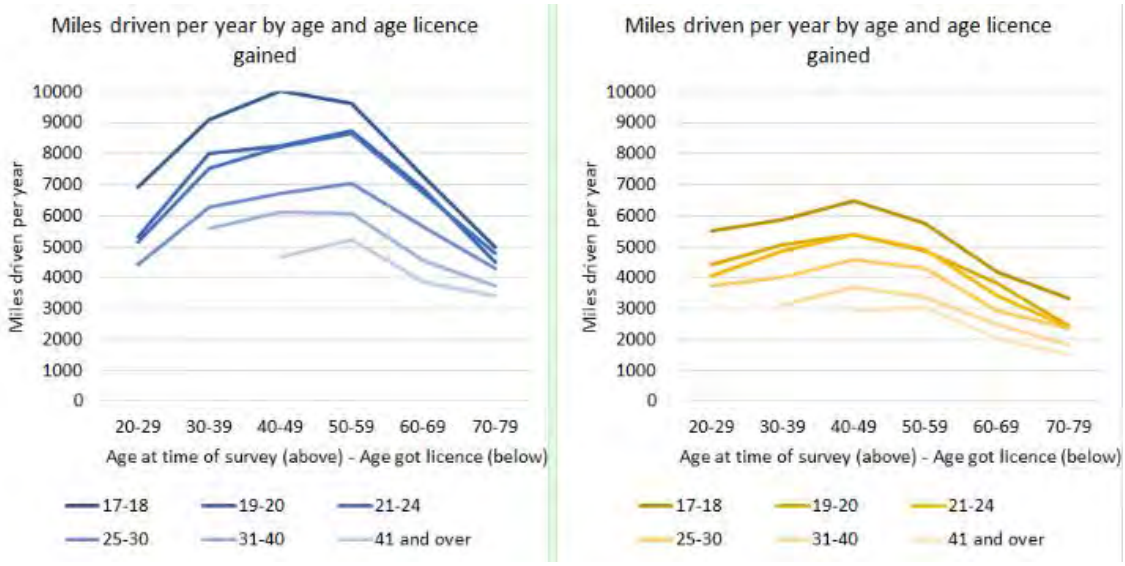


*Figure 4 – Driving mileage per year by age at which licence was gained (NTS data)*

Figure 4 strongly suggests that the later one learns to drive, the less mileage one drives. Each line shows the mileage driven per year by people who gained their driving licence at similar ages. Those

who gained licences at age 17 or 18 consistently drive further than others. For both men and women the lines for those aged 19-20 and 21-24 are similar, but those who gain their licence later show markedly lower mileage.

There are a number of possible explanations for this, including:-

- those who are smitten by the idea of driving will learn early.
- those who live in areas where a car is 'a necessity' such as rural areas will learn early.
- those who learn later have learnt other 'habits' for travel which mean that they are likely to use them more selectively.
- driving may be an activity for which learning is ‘best’ done when the cautiousness of adulthood has not yet become ingrained. For those who learn later ‘excitement’ may be replaced by ‘anxiety’ - differing reactions to the same stimuli.

## 7. Conclusions

- That age affects how we travel is beyond any reasonable doubt. We use different modes at different ages because of our changing travel needs.
- When one was born has a separate effect. Driving a car has been related to birth decade. Nearly all men still alive (and most women) grew up at a time when car driving was 'the norm'.
- There are now younger generations who have been brought up when driving is not seen as such a 'natural thing to do' as those born earlier. This has been happening for long enough to not be a ‘blip’.
- There’s strong evidence that having a car is ‘difficult to give up’ in that once people have a car and drive, they tend to carry on, even into old age and relative infirmity. There is much less evidence of ‘life habit’ formation for other modes.

Younger generations are not using cars to the extent ‘baby boomers’ did. The question is whether they will they get ‘stuck’ on public transport and/ or cycling habits that they have learnt while in ‘formative’ years, whether they will start using cars as much as the ‘boomers’ once they have families and get rid of debt they may have accrued, or whether they will do whatever is most convenient, dependent on their circumstances?

The only sensible answer to that question is "we don't know". But it does seem unlikely that they will embrace car use to the extent that many of the ‘baby boom’ generation did. If we assume that those over, say, 35, will continue with their current car access level to age 85, and will drive at rates that follow current age patterns we may have a better forecast than one based on level of economic growth. What is more difficult to predict is what today’s children and those not yet born will do!

**Commission on Future UK Travel Demand and Climate Change**

Cars and planes are mostly dependent on fossil fuels so they pose big Climate Change challenges. In comparison, rail transport (heavy, light, ultra-light) uses energy and land more efficiently and can more easily use renewable electricity.

**The Transport Group of the High Wycombe Society** here considers travel mostly about 5 miles around the town centre, plus links to London and other parts of the UK. There are three airports nearby (Heathrow, Gatwick and Luton).

1. **Geography** – Chiltern Hills, River Wye, AONB, key connections,

2. **History** - Doomsday Book, mills, railways, Beeching, road building, population growth, congestion and climate change.

3. **Some possible developments to reduce $CO_2$ emissions;**

   a) **Reopening disused rail link –** High Wycombe/Bourne End (5miles)

   b) **Traffic lights & roundabouts for smoother traffic flow.**

   c) **Car sharing,** to reduce impact on roads, parking, pollution and Climate Change…

**1. Geography.**

High Wycombe (HW) is 35 miles north west of London. It grew up in a deep valley running E/W across the Chiltern Hills, alongside the small river Wye and the old London /Oxford road (part of today's A40). Large areas of the Chilterns AONB are close to much of the town. The High Street and historic town centre are in the river valley, but today most of the town (population 133,204 urban plus rural) has been built on the surrounding hills, producing many roads with steep gradients, which consume much fuel and discourage cycling. Maidenhead and the Great West Main Line (soon also Crossrail) are in the Thames Valley 9 miles south along the Wye Valley, via Bourne End. Oxford is 25 miles to the west. Airports: Heathrow is 18 miles, Gatwick 57 miles and Luton 40 miles. Good rail services are available to London, Birmingham and Oxford; connections to Aylesbury will improve with east-west rail, which will also add routes to Milton Keynes, Bedford and eventually Cambridge; all other connections are by road. Particularly to the Thames Valley employment area and LHR airport,

**2. History:**

L**ong industrial history and railways**:

Industry was powered by water mills (driven by the River Wye) for more than 800 years. The Doomsday Book, published in 1086 and ordered by William the Conqueror, recorded 3 of the mills. In the course of the next 800 years

about 30 more mills were built along a short length of the river near HW (e.g. flour mills, saw mills and paper mills). They formed the basis of the successful industry which led Brunel to develop HW's first railway opened in 1854. The track ran along the Wye valley via Bourne End to join his great West Main Line at Maidenhead. The 5 miles between HW and Bourne End was closed in 1970, following many rail closures after the 1966 Beeching Report. A second rail link had been opened in 1905, following the shorter E/W route to London that required a tunnel near Beaconsfield. This is the track now used by Chiltern Railways.

**Road building:**

**T**he arrival of motorised traffic at the end of the 19th century made it necessary to increase the capacity and strength of roads, including the A40 in HW town centre, where huge congestion developed. In 1965 the M40 was built a mile south of the High St, and in 1969 the Abbey Way by-pass 100m south of High St, but the relief was short lived. The town centre was pedestrianised in 1998. Today heavy congestion is widespread across the District. There has been much population growth but no corresponding new infrastructure. Climate Change also demands urgent measures to reduce carbon emissions.

3. **Some possible future developments to reduce $CO_2$ emissions**

**a) Reopening of 5 miles of disused rail link** HW/Bourne End (HBL)

This could provide lower energy transport than today's cars between HW and the busy Thames Valley at Maidenhead giving access to CrossRail and the planned western access rail link to Heathrow.

In 1994, the track was surveyed voluntarily by Christopher Wallis, a leading engineer who lived locally and who had played a key role in rescuing the Settle/ Carlisle railway. In 1994 a few short lengths of the HBL track had been built over, and simple reinstatements were feasible. The Transport Group campaigned for the track to be protected. This was granted for a short while but since then more of it has been built on and re-instatement is still feasible, but more expensive. Privately funded professional studies have confirmed this feasibility. Perhaps the pressures of Climate Change, new housing, and congestion will now justify the costs of reinstatement. *Weak planning protection of routes where development or changes in population would suggest re-opening, is an area that warrants investigation on a national basis.*

**b) Changes to Traffic lights and roundabouts** to aid smooth traffic flow and save energy. A member of the Transport Group has made an exhaustive study of a large number of these in HW, and accordingly has recommended that several of the lights be removed and replaced with a roundabout.

**c) Car sharing** - to reduce the number of journeys and so minimise the impact on road space, parking spaces, pollution and climate change. Busy destinations, such as stations, town centres, industrial estates etc. often require car transport for door-to-door journeys. Modern telecommunications and computers make it possible to maintain easy contact with relevant sharing

vehicles, and to receive and process journey information to identify convenient sharing. This matching of journey requests is usually easier during the busy periods. The shared vehicles may be part of a dedicated car-sharing workforce, or they may be volunteers from among staff of other businesses. Several different arrangements have been developed. The sharing could often involve sharing with strangers in a strange car, so it is important the booking procedure provides records of the vehicle, the people in it, and its continual whereabouts. Also there needs to be regulations directed at ensuring the shared vehicles are kept mechanically in good order and clean, and that the drivers are competent and responsible.

The measures reviewed in 3a – c above could reduce the road transport CO2 emissions and the land take for roads and parking in the HW area, but these changes would likely be small compared with the emissions and land take associated with the three international airports (Heathrow, Gatwick and Luton) within 20 or 50 miles of High Wycombe.

A new synthetic material suitable for building aircraft is said to be much lighter than the aluminium now used but the air travel emissions would still be considerable. If future travel demand is to make a contribution to reducing climate change a new kind of international agreement to reduce air travel will be essential.

**Institute for Transport Studies**
FACULTY OF ENVIRONMENT

UNIVERSITY OF LEEDS

# The Value of Spatial Analysis in Understanding the Demand for Cars

## Evidence from an emerging field of inquiry

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# INTRODUCTION

The provision of personal mobility in the United Kingdom (UK) has become increasingly reliant on the use of private cars over the past twenty years. This reliance is clearly apparent in public statistics which describe Great Britain's transport system[1], whereby cars, vans and taxis accounted for 658 billion passenger kilometres travelled in 2015, which represented an 83% share of the market. Indeed, over 30 million cars were registered for use on Great Britain's roads in 2015, with the level of registrations having expanded by 41% since 1995. The dominance of the car in providing personal mobility is motivated by its relative advantage compared to other modes of transport, granting drivers unique affordances such as seamless mobility, luggage capacity and a personal environment in which to travel in. Though a range of scenarios, normative visions and radically different alternative futures for transport have been proposed, it is challenging to produce a realistic forecast for transport demand which does not see the dominance of the car continuing for foreseeable future.

The current central position on the car in the delivery of personal mobility means that understanding the features of the system represents an important issue for the governance of the transport sector. These system features can be approached from a number of different perspectives, which each reveal unique insights. In this report, focus is given to the geographical format of the car fleet in order to consider how its structure changes across space. Such an approach is useful in comprehending the influential role that environmental circumstances play in conditioning the geographical organisation of the fleet. To demonstrate this, the report provides a brief overview of the conceptual framework which directs spatial investigations in fleet structures and concludes with a number of short case studies to illustrate the value to be gained through applications of spatial analysis concerning fleet organisation.

[1] Transport Statistics Great Britain – available at: https://www.gov.uk/government/collections/transport-statistics-great-britain

# BACKGROUND

As a result of the widespread uptake of cars across the UK, local markets can be distinguished whereby individual registrations are aggregated together to reveal the cumulative preferences of the population. These aggregated preferences can be mapped to illustrate the spatial heterogeneity which exists regarding the characteristics which are being examined. For instance, aggregating vehicle registrations by fuel type allows for regions to be identified that have higher market shares of certain propulsion systems (i.e. petrol or diesel engines).

The identification of spatial heterogeneity in the car fleet indicates the presence of underlining factors which direct the aggregated purchasing behaviours observed in certain areas. To date, researchers have tended to approach these underlining factors from an environmental deterministic perspective. That is to say, the reasons why certain areas display particular preferences for cars is due to the unique conditions present within those areas. These environmental conditions can be assigned to three broad categories. The first is the demographic arrangement of the population, covering such issues as age structures, education levels, household incomes and gender splits. The second is the features of the application environment, linked with the travel patterns of the population, the structure of the road network and the prevailing climatic conditions. The third is the presence of local policies, such as preferential parking for certain car variants, local fuel duties and road user charging. Figure 1 illustrates how these three categories of environmental conditions affect the structure of the local car fleet.

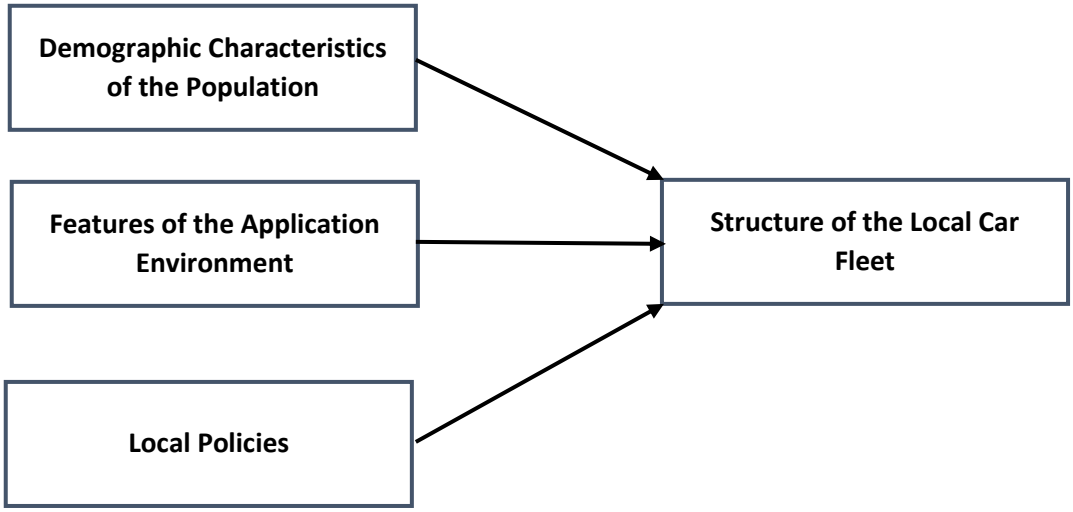


**Figure 1**: Structural framework illustrating the environmental conditions which effect the configuration of local car fleets

To begin with, research principally focused on understanding the environmental conditions which explained household car availability. This initial research brought to light the different factors which appear to direct households towards car based mobility, allowing strategies to be developed in order to reduce car reliance. Currently, research into the geographical structure of the car fleet is progressing due to increases in the richness of the data available which allows local fleets to be distinguished according to a wide range of technical characteristics. The following three case studies demonstrate how this data can be utilised in order to provide knowledge regarding the development and effectiveness of government transport policy. Illustrations linked to the case studies are available in the appendix of this report.

# CASE STUDIES

## Case Study One

### Title

Evaluating the Impact of Local Transport Policies over the Adoption of Low Emission Vehicles

### Topic Outline

Local transport policy makers have a variety of different options available to them in order to stimulate the demand for certain types of vehicle. One such option is associated with urban vehicle access regulations, whereby certain vehicles can be granted preferential terms of access. An example of this is the London Congestion Charge (LCC), where buyers of new Hybrid Electric Vehicles (HEVs) in the UK were exempt from having to pay the entrance fee up to 2013.

### Research Focus

This project considered if the exemption of HEVs from the LCC promoted the adoption of these vehicles and, if so, if this effect decays as nearness to the LCC diminishes.

### Research Status

This project has been completed.

### Results

A substantial degree of geographical variation in the adoption of HEVs is present across the local authorities of Great Britain (Figure 2a). This variation exhibits a significant level of spatial organisation, with a hotspot of uptake (shaded deep red) centred on the metropolitan area of London (Figure 2b). As local authorities retreat in contiguity to the LCC, the rates of HEV adoption tend to decrease (Table 1). As local authorities recede in proximity to the LCC, the rates of HEV adoption tend to decrease (Figure 3a). As local authorities increase in interaction with the LCC, the rates of HEV adoption tend to increase (Figure 3b). These effects remain having controlled for the influence of demographic characteristics of the population and features of the application environments.

### Insights

The findings of the research suggest that the exemption of HEVs from the LCC stimulated uptake of these vehicles in the vicinity of London. As the primary objective of the of the LCC is to reduce congestion, the efficacy of the HEV exemption in achieving this objective is questionable, which demonstrates the trade-offs that are often present in transport policy where different objectives might be mutually exclusive.

# Case Study Two

### Title

Spatial Arbitrage in Fuel Prices and its Effect on the Structure of the Car Fleet

### Topic Outline

The crossing of national borders often involves switching from one fiscal regime to another. Moving between different taxation policies has the potential to generate economic opportunities, if the regime in one of the jurisdictions is more conducive to a certain activity. Of particular relevance to the transport sector, the rate of duty imposed on fuels can be asymmetrical in different areas, which may allow for marginal profits to be generated if the fuel is purchased in one taxation regime and sold or used in another (i.e. a spatial arbitrage). A possible example of this is present in Northern Ireland, whereby the price of diesel is noticeably higher as compared to the Republic of Ireland (21 pence per litre as of 2012). This price differential may encourage a number of different activities, such as drivers in Northern Ireland refuelling in the Republic or the smuggling of fuel across the border.

### Research Focus

This project considers if the diesel fuel price differential observed between Northern Ireland and the Republic encouraged Northern Ireland residents to purchase diesel cars.

### Research Status

This project is currently active.

### Preliminary Results

The structure of Northern Ireland's car fleet is rather similar to other Government Office Regions on a number of characteristics, with its local authority fleets being middle of the road in terms of average engine size (Figure 4a), average age (Figure 4b) and average mass (Figure 4c). Concerning the proportion of local authority fleets fuelled by diesel, Northern Ireland stands apart from the other Government Office Regions, displaying a substantially higher mean percentage of diesel cars at 55%, whereas the rest of the UK has an average of around 35%. Exploring the percentage of the local car fleet fuelled by diesel across the super output areas of Northern Ireland, the results indicate that areas closer to the border with the Republic tend to have higher rates of diesel cars (Figure 5). These preliminary results suggest that nearness to the border with the Republic is positively associated with the registration rates of diesel cars. In order to determine if access to cheaper fuels across the border is promoting the adoption of diesel cars, further analysis is required to control for the effect of confounding factors such as rurality (with rural areas expected to display higher levels of diesel car registrations), population age structures (with middle aged populations expected to display higher levels of diesel car registrations) and travel to work patterns (with longer commutes by car expected to display higher levels of diesel car registrations).

### Insights

When finalised, this research is anticipated to illustrate how the ability of national governments to influence the structure of the car fleet can be constrained by factors outside of their immediate control. That is to say, the influence of the fuel duty policy in effect in Northern Ireland is diluted by the influence of the fuel duty policy in effect in the Republic.

# Case Study Three

### Title

Assessing the Distribution Impacts Associated with the Introduction of Vehicle Access Regulations

### Topic Outline

Across the UK, cities are investigating the possibility of introducing vehicle access regulations which restrict the access of certain polluting vehicles to specified areas in order to improve levels of air quality. For instance, the Mayor of London is considering the introduction of an Emission Surcharge, which would cover an additional fee of £10 to cars not compliant to the Euro 4 emission standard to enter the LCC. The possibility exists for such a policy to introduce outcome inequalities, whereby the interests of certain social cohorts (i.e., those currently exposed to high levels of pollution in the centre of London) are given precedence over the interest of other social cohorts (i.e., those that currently own non-complaint cars). If such an outcome is likely to occur, it is important to consider who these marginalised groups are and if any adverse consequences of policies of this nature can be mitigated.

### Research Focus

This project measures the geographical variation in the rate of non-compliance to the proposed Emission Surcharge across the lower super output areas of London and links this to the demographic arrangement of the population.

### Research Status

This project is currently active.

### Preliminary Results

London on average has the highest rate of cars not compliant to the Euro 4 emission standard of all Government Office Regions (Figure 6). The rate of non-compliant cars varies substantially across the lower super output areas of London (Figure 7a). This variation is also spatially concentrated, with a number of hot spots (shaded deep red) and cold spots (shaded deep blue) of compliance being present (Figure 7b). Linking the rate of non-compliance to the demographic structure of London's population, a number of significant relationships are identified. Non-compliance is positively associated with the rate of unemployment (Figure 8b), bad health (Figure 8c), black, Asian or ethnic minority (Figure 8d), Muslims (Figure 8e), lone parents (Figure 8f), no educational qualifications (Figure 8g) and social renters (Figure 8h) whilst being negatively associated with median household incomes (Figure 8a). To consider if this generates adverse consequences requires further work to better assess the level of exposure to the policy (taking into account additional factors such as differences in levels of motorisation between areas and the degree of interaction between an area and the LCC), as well as the sensitivity to the surcharge (i.e. the financial capacity to maintain current travel patterns by paying the surcharge) and the level of adaptive capacity (measured by the ability to transfer mobility to active and public transport in order to access the LCC).

### Insights

When finalised, this research will likely demonstrate that cars not compliant to the Emission Surcharge tend to

be registered in areas that have a higher prevalence of marginalised social groups. Thus, the pursuit of one government policy (i.e. air quality) could led to the degradation in another (i.e. social equality).

# Summary

One of the biggest challenges facing the transport system is the requirement to transition towards a sustainable pathway, where mobility is affordable, equitable and clean. Currently, it is difficult to envisage a realistic future for the transport system where the car no longer has a prominent role, due to the lack of an apparent successor. As a result of this, determining how the car fits into a sustainable future is of clear importance, one that will significantly affect whether or not a sustainable future for the sector is achieved.

Through the case studies presented, this report demonstrates how an understanding of the geographical demand for cars across the United Kingdom can reveal a number of hitherto unobserved issues that are closely connected to the governance of the transport system. The insights generated from analysis of this nature have practical value in the development of strategies to support a sustainable transition. For instance, knowing the degree to which the market for low emission vehicles can be stimulated by local policies could be useful to transport planners that are considering introducing vehicle access regulation schemes. Moreover, understanding how the transport system of one jurisdiction is effected by the policies enacted in another jurisdiction signifies the need for collaboration between and across regional and national transport bodies to limit the occurrence of unintended consequences.

The opportunities which exist for further work which utilises the novel data concerning the spatial configuration of the car fleet to generate new insights regarding what factors shape the fleets' organisation are extensive. The research summarised in this report represents only the initial steps along this new direction for transport research, with valuable knowledge still remaining to be discovered.

# APPENDIX

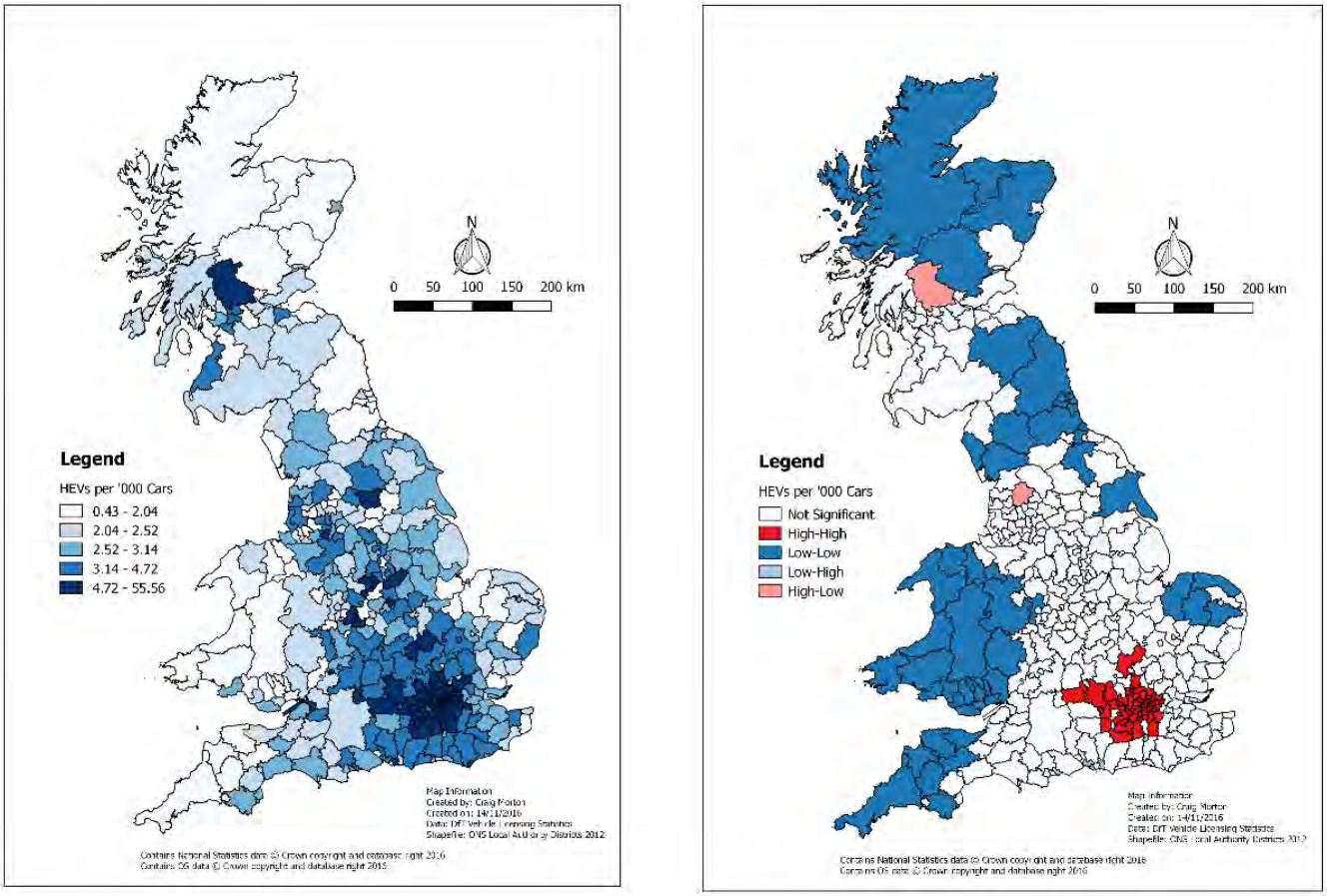


**Figure 2:** Maps illustrating the (a) rate of Hybrid Electric Vehicle adoption and (b) clusters of Hybrid Electric Vehicle adoption across the local authorities of Great Britain

**Table 1:** Descriptive statistics of Hybrid Electric Vehicle registrations (per thousand private cars) across different local authority categories

| Local Authority Category | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| London Boroughs (n = 32) | 10.58 | 6.81 | 2.00 | 30.98 |
| First Order Neighbours to Greater London ( n = 16) | 8.34 | 8.88 | 2.61 | 38.96 |
| Second Order Neighbours to Greater London (n = 23) | 4.31 | 1.33 | 2.27 | 6.90 |
| Rest of Great Britain (n = 303) | 3.22 | 4.00 | 0.43 | 55.56 |

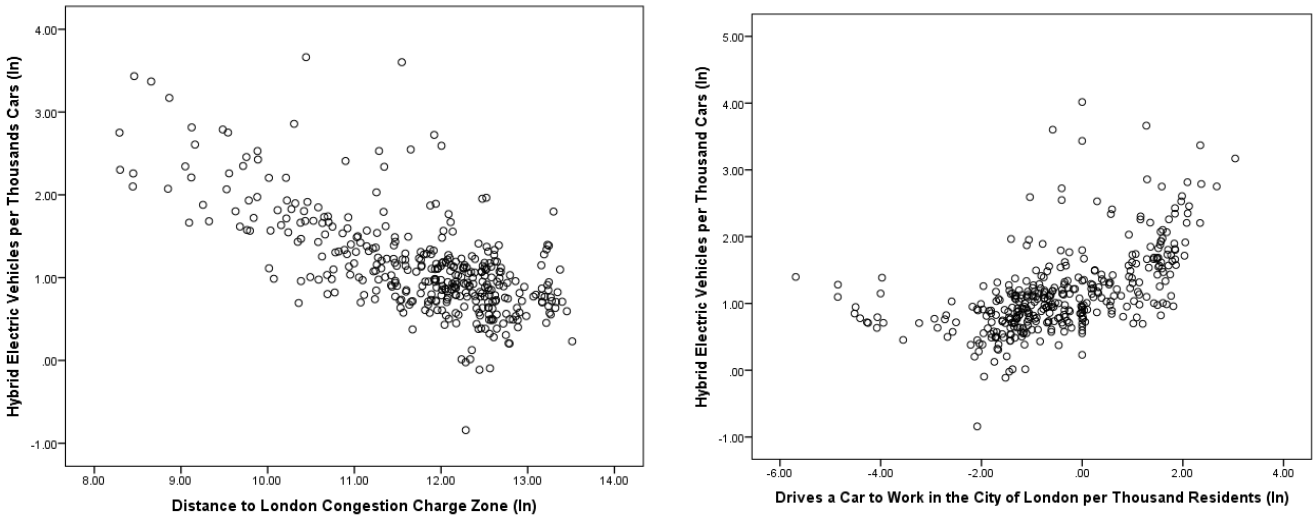


**Figure 3:** Scatterplots of Hybrid Electric Vehicle registrations (per thousand private cars) against (a) distance to London Congestion Charge and (b) residents that drive a car to work in the City of London (per thousand residents)

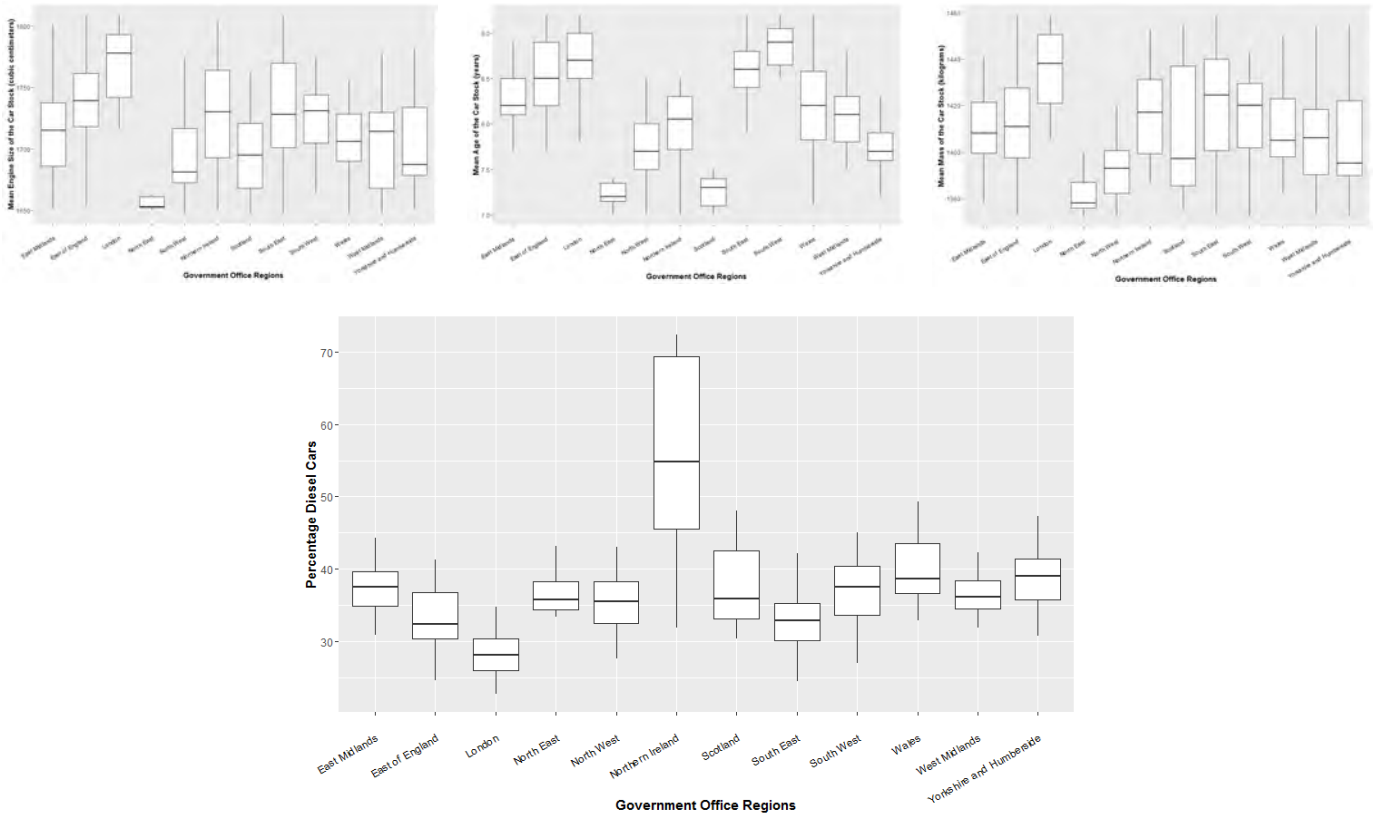


**Figure 4:** Boxplots displaying the distribution of local authority car fleet technical characteristics grouped by Government Office region for (a) mean engine size, (b) mean age, (c) mean mass and (d) proportion diesel

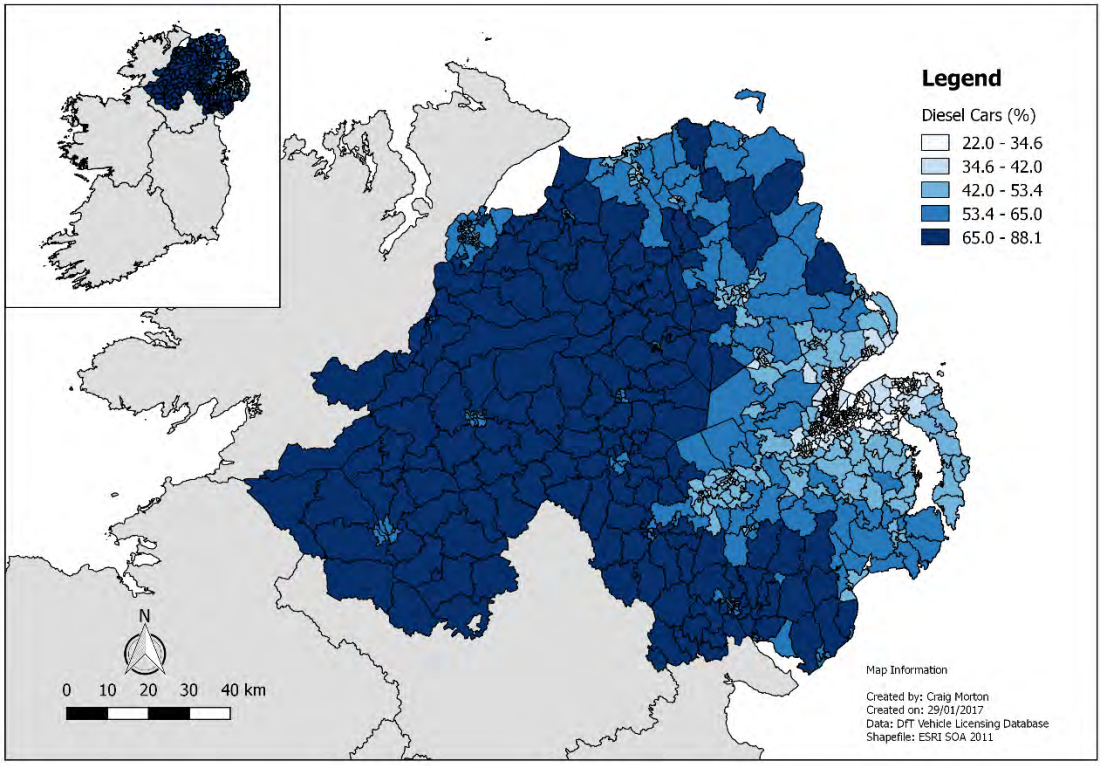


**Figure 5:** Choropleth map displaying the proportion of the local fleet fuelled by diesel across the super output areas of Northern Ireland

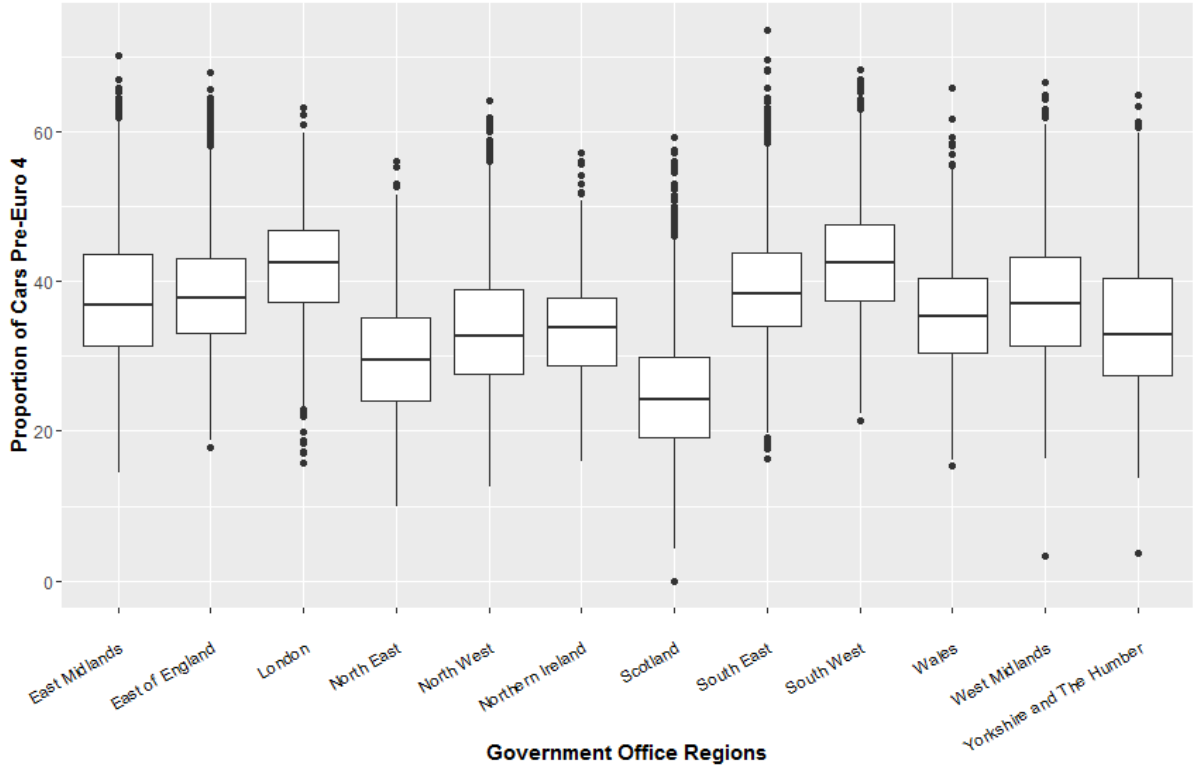


**Figure 6:** Boxplots of the percentage of cars that are diesel fuelled across lower super output areas grouped by Government Office Region

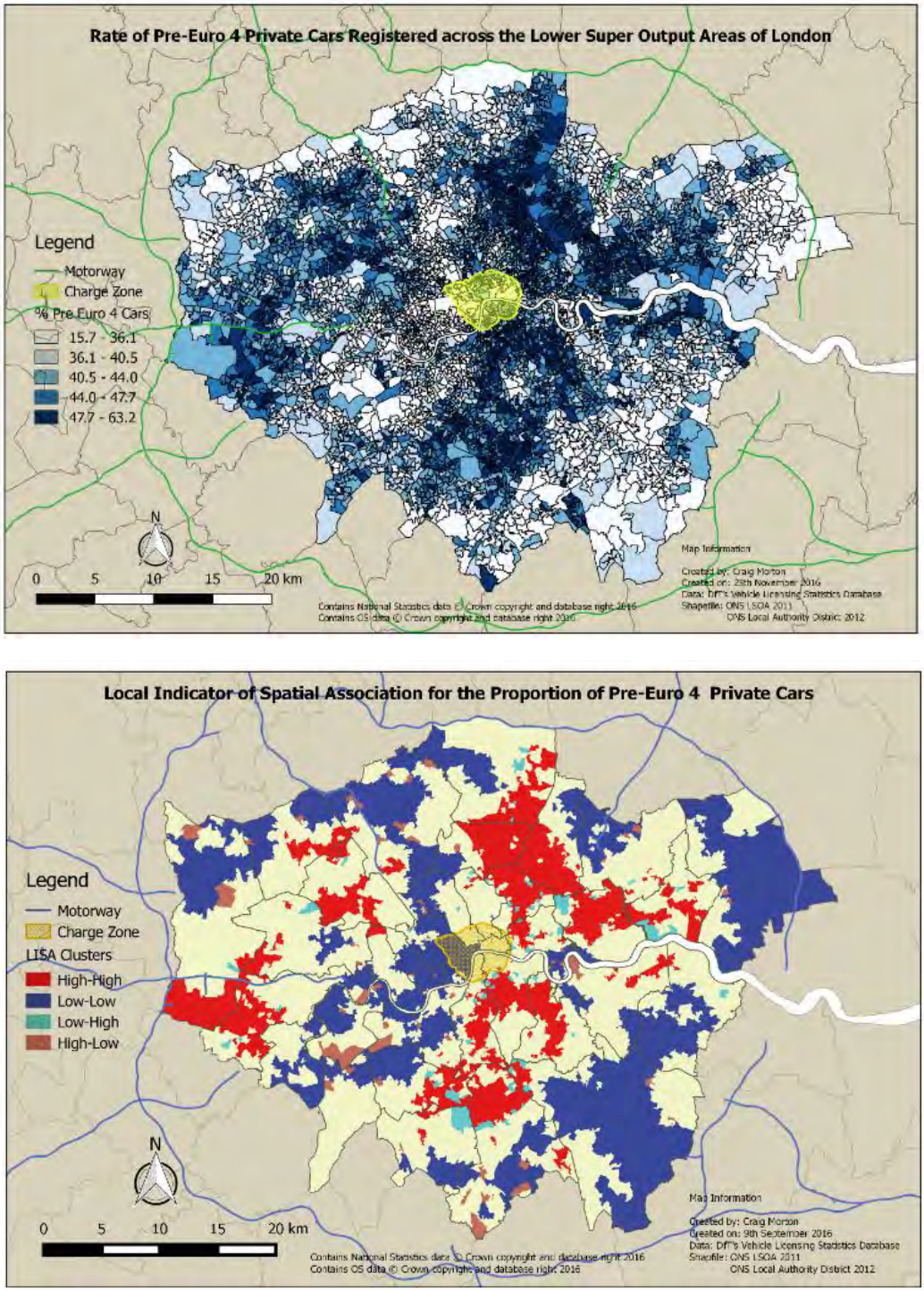


**Figure 7:** Maps illustrating the (a) rate of Diesel Car ownership and (b) clusters of Diesel Car adoption across the lower super output areas of London

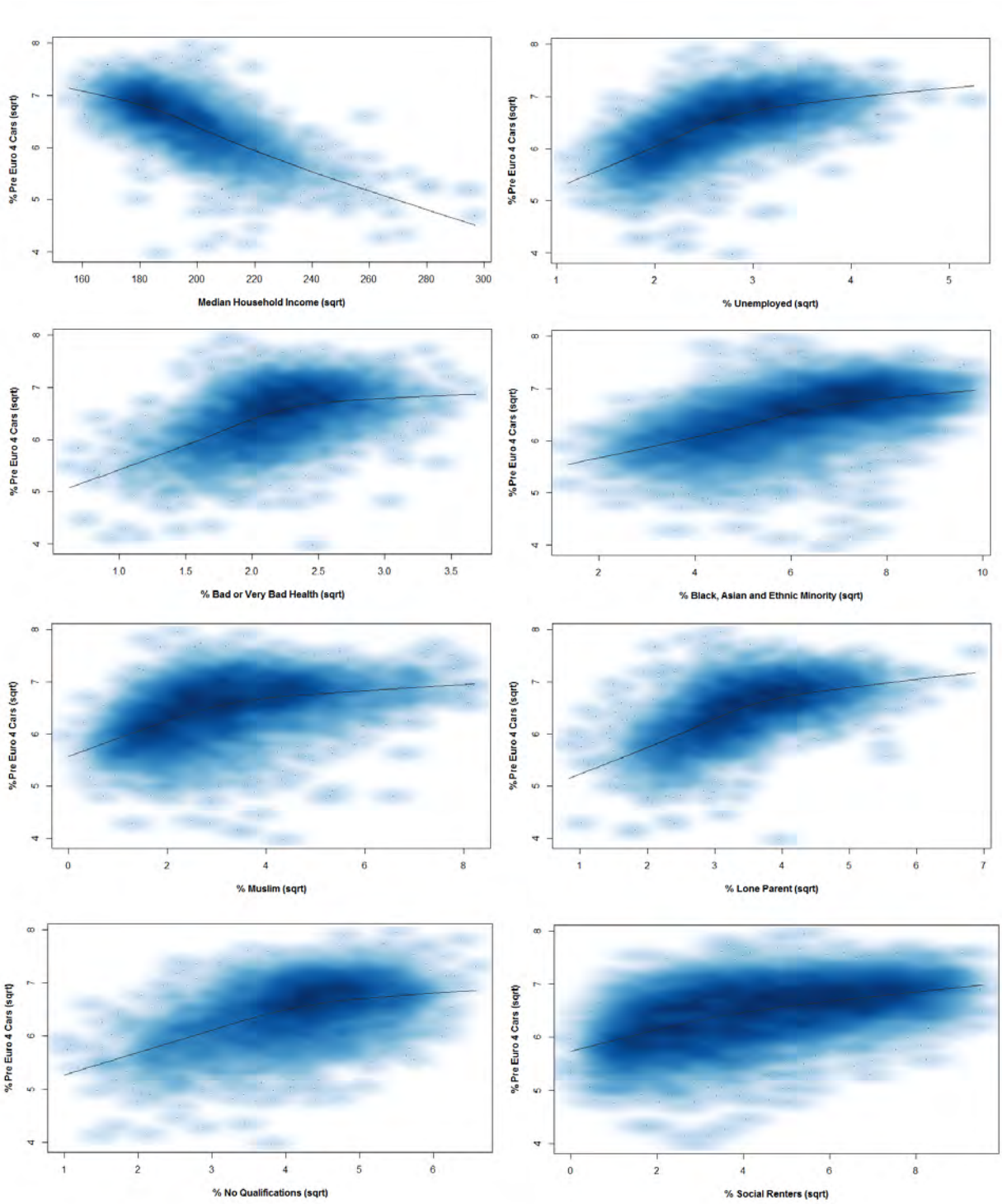


**Figure 8:** Scatterplots which chart rate of non-compliance to the Emission Surcharge (y-axis) against elements of (a) household income, (b) unemployment, (c) health, (d) ethnicity, (e) religion, (f) household structure, (g) education and (h) household tenure

# Rail demand forecasting – ten lessons of a lifetime

**Lesson 1: Unexpected changes in the supply side can undermine demand forecasts**

The case of Eurostar and CTRL is widely regarded as a good example of poor forecasting. But projections of very high rail market share of London- Brussels (60%+)/Paris (80%) markets for Eurostar based on logit models made in the period 1992-4 were accurate and borne out in practice.

The area of inaccuracy lay in (what seemed a less risky) presumption of a small market share of the much wider and multiple travel markets between the wider GB geography and the near European continent. But here the observable habits of long distance rail travel across EU member state borders simply failed to develop. There are three main reasons why this happened:

1. The UK opted out of the Schengen Agreement in 1999 and this meant that border crossing got harder not easier by rail and timed interchanges for onward travel became problematic
2. The various state railway companies and Eurostar failed to agree an integrated ticketing strategy that made through booking feasible
3. Services for which entire train fleets had been bought – the Regional Eurostar fleet and the Night trains fleet – were never introduced into service.

This is the same type of problem that arose with economists' failure to foresee the credit crunch: the demand models in use were acting within a shock-free continuity framework.

So Eurostar only has passenger volumes of 10mppa (about half of what was forecast). Whether new services will make a significant difference (Eurostar to Amsterdam later this year) and Deutsche Bahn to Frankfurt (announced 5 years ago) – i.e. more supply side changes – remains to be seen. But meanwhile Brexit threatens and border control anxieties grow, so the context for any market outlook has changed dramatically since the 1990s. These external changes would have seemed far-fetched in the early 1990s and not worth even a sensitivity test, not that the requisite variables featured in the demand models.

Turning from the specifics of Eurostar to the question of infrastructure use, CTRL now carries 20m passengers/year – there are now 10mppa using South Eastern's high-speed services (alongside the 10mppa on Eurostar). This reflects a supply side (train service) change but in the opposite direction to those affecting Eurostar. When the merit of CTRL was being debated, no domestic service plans had been developed. Moreover, the South Eastern high-speed demand looks set to continue to grow if sufficient additional capacity is provided (peak passengers stand from Ashford currently). As far as CTRL is concerned, it's a Lesson 2 case..

**Lesson 2: Some demand forecasts are right for the wrong reasons….**

A good example of this is the Borders railway where demand has exceeded expectations at some stations – massively so at Galashiels and Tweedbank – but has fallen well short at others (stations such as Eskbank and Newtongrange, closer to Edinburgh); overall ridership is somewhat ahead of first year forecasts, and this despite poor service reliability. The reasons for these discrepancies are perhaps easier to fathom than the Eurostar case.

The over-achievement at Galashiels/Tweedbank is likely to be due to a high number of trialists (a category often excluded from formal forecasts – their inclusion sometimes seen as 'scraping the barrel') and a significantly higher level of induced demand, partly tourist-based (and subject to fashion factors that are hard to estimate), but also because, taken in the round, the rail service *from* the remote Borders' towns represents a step change in quality for travel to central Edinburgh – and step changes are areas of intrinsic high risk in forecasting.

The reason why the close-to-Edinburgh demand is *lower* than expected are likely to be that housebuilding in these areas is behind schedule and the time-lag in changing patterns of commuting from existing residential areas takes a long time to work through (we estimated over 20 years in the case of the Bedford – St Pancras – Moorgate electrification scheme in a 1980s Steer Davies Gleave study for Network South East).

**Lesson 3: ….and other forecasts are right despite everything going wrong!**

Seen as a very high risk forecast at the time, the Virgin Trains bid for the West Coast franchise made 20 years ago projected a threefold increase in demand over the 15-year life of the franchise. Despite serious and highly publicised disruption during the renewal/upgrade programme in the 1999-2004 period; despite the late delivery of the planned transformational infrastructure upgrade and despite the technology on which faster speeds were predicated (a new cab-based train control system) being abandoned and the plan to operate at 140 mile/h also lost…the tripling of demand happened only one year later than projected in 1997.

Of course, not everything did go wrong and the long franchise timescale (15 years) was in practice a time horizon that would have seemed luxurious to (say) BR's management who were subject to annual budget-setting and it provided sufficient time to overcome problems.

When a business depends on hitting its demand and revenue targets, it is more likely to achieve them. Forecasting is not a pure science (where outcomes must be independent of key actors' behaviour).

**Lesson 4: Markets change over time…**

The majority of long distance rail travel in GB is now non-discretionary; thirty years ago two thirds of intercity travel *was* discretionary (holidays and visiting friends and relatives etc). Family travel was once a significant category; under-16s travelled unaccompanied and now rarely do; travel for sports and other events by rail was much more common; armed service travel by rail was also a significant category 30 years ago and has largely disappeared.

Business travel by rail has boomed as mobile comms/computing has made train travel highly productive. This effect has (so far) outweighed the substitution effect of using telecoms instead of travelling for face to face meetings, and probably helped create a more spatially dispersed professional/managerial workforce.

Looking at total demand, over time, trends may look stable, but they can be masking very large changes. Disaggregated forecasting, at the level of market segments, desirable though it may seem, may produce less accurate results.

**Lesson 5: ….and so do market shares, although demand models regularly presume very limited modal switching**

Over a period of 11-12 years from 1995, the rail market share of all travel over 25 miles (which is dominated by car, despite the existence of coach and air alternatives in some markets) grew from 8% to 14%. This is a very significant change, and it was hard to foresee. Between 1950 and 1997, rail travel in the UK had remained hovering around a total of 20bn passenger miles *per annum.* Since then it has grown to nearly 40bn.

Typically, demand models imply only modest levels of mode switching in the comparisons of do something *vs* do not which are used to underpin economic appraisals. So even with large changes, HS2 is reckoned to only attract 4% of its custom from car – attracting the complaint that 'it won't make much difference'.

But over time, it will make a difference. This is because a significant modal capacity increment, like HS2, will support a higher rail mode share than would otherwise occur. The models don't show this effect. HS2 demand is most likely under-estimated.

The lessons of history may or may not apply. Andrew Evans, analysing the effects of the WCML electrification project of the 1960s estimated that of the substantially increased volume of rail travel observed, roundly 50% was diverted from other modes and 50% was 'induced' – travel that would not have otherwise occurred (at least along the West Coast corridor). Induced (or generated) demand is often treated with scepticism (despite the evidence from the M25 for which qualitative research prior to its opening revealed expectations of small flows/no congestion (where would the traffic all come from?). Its economic value is also discounted by a loose consensus view of those engaged in transport policy that extra travel should be discouraged. But induced demand is significant in the case of many rail projects and policies.

In France, the huge success of the first TGV line in 1981 is generally attributed to the near-halving of the Lyon – Paris journey time to a nice memorable 2 hours. But qualitative research in France at the time (unpublished) showed that a major factor in mode switching was the introduction of a new seat reservation system, that could be changed/validated up to 5 minutes before the journey (a technological feat still not achieved in GB) and this could be done from home using the unique French Minitel system that used a domestic phone line: an internet capability, if you will, well before the world wide web.

Mode split models are not where the big shifts in mode use occur in forecasts such as those used for HS2: they arise from assumptions about 'base' demand in future years compared with today, where it is impossible to ignore the highly differentiated trends in travel trends by mode. These underlying mode-specific trend growth assumptions should be given much more scrutiny.

**Lesson 6: Service frequency really matters – as do through trains**

This was established through some ground breaking research commissioned by BR in 1980. I was part of the consulting team at Steer Davies Gleave that did the work using conjoint multivariate analysis. This introducing Stated Preference (SP) techniques for the first time into policy research in the UK. Stated Preference is a misnomer – at least if research is conducted the way that was used in this first 1980 research study, where a 'Journey Planning Game' tool was used to in an in-depth interview to replicate a structured set of travel choices, tailored to the very specific circumstances of each respondent's journey, including in terms of access to information and perceived choice sets.

The research showed that there were high levels of elasticity with respect to travel frequency - especially for business travellers and high levels of resistance to the need to change trains *en route* - especially for leisure travellers. This quantitative research, incorporated into the PDFH 'bible', underpinned the service uplifts and the transformation of ridership on the 'Other Provincial Services' that became the 'Regional Railways' sector.

**Lesson 7: Changing mode car to rail ('park and ride') *en route* has not been accurately forecast (but could be)**

In depth research with travellers shows high levels of anxiety about using station car parks, especially if they are remote from either end of the journey. Demand models of course may apply an interchange penalty, but they don't distinguish (assuming they have a mixed mode capability, which most do not) between proximate and non-proximate rail-head sites.

Major park and ride facilities that rely on a wide catchment, especially if combined with limited train frequencies that add to anxiety about return journeys, have in general under-achieved against expectations (Alfreton & Mansfield and East Midlands Parkways for example). Stations such as Bristol Parkway, on the other hand, where there are back-up taxis and multiple bus lines (so less anxiety) *and* high frequency train services that are quicker than those involving a city centre station *and* a generally closer catchment have out-performed expectations. In fact, Bristol Parkway is so far unique in demand generation. Non-Parkway stations such as Doncaster also perform well serving wider catchments because they offer choice and security for return travellers.

Sometimes, Lesson 2 type countervailing factors come to the rescue. Tiverton (mid Devon) Parkway has succeeded with a much higher than projected induced rail demand from nearby areas (Tiverton, for instance) and lower than projected numbers from further afield (North Devon, for example, it being a remote station for many candidate users).

**Lesson 8: Fares elasticity effects are now buried in complexity**

By the early 1990s, BR could predict the effects of fares level changes reasonably accurately, with measures disaggregated by journey purpose and trip length. But this was before yield management systems came onto the scene and a number of TOC-specific fares offers were overlaid on top of the already complex tapered mileage-based system of charges that BR used, complete with its set of railcard-based discounts. And it was also in an era of more normally distributed income levels so that

a single price-point had more traction. With increased income disparities have come much wider top and bottom fares to segment the market. Oh and then there's the deep discounts that split journey ticketing offers.

With fares level regulation half-applied, the scope to alter the applicability of fares restrictions case-by-case adds another layer of detail that makes it very difficult in a demand forecast to assume anything other than the same fares system applying in the do something/do not pair of cases. It just means that an investment partly predicated on a fares change, once considered by BR to be a near normality, for example, with a new train fleet, is impossible to forecast reliably and has thus fallen out of use: an odd case of analytical short-comings precluding a common-sense policy. Although there has been one major exception in recent years, namely the 30% premium applied to SouthEastern's fares of the high-speed service.

Rail fares: too complex for travellers, ditto modellers and regulators, yet commercial operators know how to work the system and each year they shuffle fares' baskets to ensure they deliver higher yield/passenger-km.

**Lesson 9: the analytic presumption of demographic and land use stability has led to serious under-estimation of demand on new lines**

But fortunately, poor benefit cost ratios (BCRs) and the opinion of rigid model-driven economists don't always win the day. Two examples…

The East London Line extensions project – together with a service plan change instigated by the SRA – led to the creation of the London Overground. Widely recognised as one of the major rail sector successes of the last 15 years, ridership has exceeded all expectations. The *ex-ante* models showed low levels of demand from a catchment demographic that made few journeys other than very local trips and were therefore unsuited to rail. As a result, the BCR was a bare 1:1 (and that was before construction costs climbed yet again). The argument used with Ministers of the day was that this was a project that served an arc of multiple deprivation through inner East and South East London (and it did).

Upon – and in expectation of – the project's implementation, these very catchment areas of the East London Line became fashionable and gentrified and travel increased hugely. Few saw it coming, and it would have been very difficult to make an investment case presuming that kind of dramatic change.

The better known example is the Jubilee Line Extension, again with a poor BCR (1.1:1). Opposed by DfT, and by TfL, and by the City of London Corporation, this scheme was forced through at Prime Minister level with the backing of Michel Heseltine who had championed Docklands regeneration. But the BCR and the demand forecasts (from TfL) presumed that there would be no change in land use in Docklands as a result of the project. Demand forecasts were low (indeed the London model used had no provision in its base case leave alone its do-something case, for Docklands growth: it had come from the Central London Rail Study (the clue is in the name)).

This analytical nonsense was apparent at the time to supporters of the project.

But not only was a very important project implemented despite a very poor demand forecast, it soon became clear that demand would be much higher than the models had projected. Meanwhile, the scope to secure even greater land value capture had slipped by: the models suggesting it wouldn't happen – a real price of analytical short-comings.

**Lesson 10: We've run out of incremental capacity, so now the modelling gets much harder**

Through the 1990s and 2000s, there was a lot of scope to increase rail capacity by lengthening trains and squeezing a few more services on to the network. But that scope is running out fast – especially in the south east. We are in a new era.

Even small levels of demand growth in the London commuter peaks now lead to extended journey times (at key stations such as Clapham Junction, the turnover of passengers on peak trains cannot be handled within the allotted station dwell times). On longer distance services, weekend peaks lead to lengthy journeys with standing passengers. In the North, more rolling stock can be accommodated more readily, but even so peak time pressures are significant.

Little is known about the feed-back effects in these circumstances. People assume that the advertised train service (on which they have made house and job location decisions) will indeed run and will accommodate them. But often trains at intermediate stations in the commuter peak have no spare capacity and cannot be boarded: journey times can be much greater than expected.

Travel adjustments are possible for some – working partly at home and on a less than a 5 day/week commute basis has grown substantially. So relationships between employment forecasts and peak travel demands will need to be revisited.

It is hard to deduce what the benefit is (and demand reaction to) a reduction in levels of overcrowding. This is rapidly becoming a key benefit of transport investment, yet its assessment is ill-served by models that seek to measure the effect of changes in the proportion of in-train times which are crowded – with such travel given an extra generalised cost weighting to reflect perceived discomfort.

The benefit metric is unclear and the effects of crowding relief on demand (including the release of congestion-suppressed demand) is very difficult to estimate. So this is an area needing much more research and development.

**Jim Steer**
January 2017

These notes are personal views and not the views of Steer Davies Gleave or of Greengauge 21.

# Generational Change in Travel Demand:
## A Submission to the Commission on Travel Demand

After the turn of the millennium it is apparent that we have witnessed a generational change in travel demand. Young adults are driving much less than previous generations and it is not a temporary phenomenon associated with the economic crisis of 2008 but a longer term shift that started in the early 1990s. This had not been anticipated in Department for Transport forecasts of future travel demand but there is a need to plan and adapt to this new reality.

The generational change in travel behaviour is not unique to the UK and a similar phenomenon has occurred in most industrialised countries (ifmo, 2013). It has been the subject of global research interest in the last few years and I have been commissioned to undertake a review for the Department for Transport seeking to understand the causes and implications. The findings will be published later in 2017.

One thing that has become apparent is that existing forecasting models are not equipped to predict generational change of the kind that we have witnessed. They assume stable relationships between travel demand and demographic, socio-economic, geographic and transport factors. However, it has become clear that travel demand relationships can change over time (Sanko and Morikawa, 2014). They can also vary among the population (Vij et al., 2017).

In analysing social change it is important to recognise the existence of three types of time-related variation (Yang, 2007).

- Age effects: variations associated with age that remains more or less stable over time;
- Period effects: variations over time that affect everyone simultaneously, irrespective of their age; and
- Cohort effects: changes across groups of individuals who experience an initial event together, such as their birth year.

Considering the existence of these three effects has helped understand the generational change in young people's travel behaviour.

Age effects relate to the progression of travel demand over people's lives. Transport forecasting models already include relationships which recognise that travel demand varies with life circumstances (such as living situation and employment status). But a body of recent research (adopting what has become known as the mobility biographies approach – see Lanzendorf, 2010) has investigated, using longitudinal data, how events in the life course directly influence travel behaviour. This has demonstrated the sensitivity of travel behaviour to events such as starting employment, birth of a child and moving home (Chatterjee et al., 2013; Clark et al., 2016). We know that young people's lives in early adulthood are very different today than 30 years ago and much more volatile (with respect to education, employment and family). Hence to anticipate future travel demand we need to represent the life course development profiles of the population and how their travel demand responds to these.

Period effects relate to time-limited effects on travel demand that affect the whole population. Transport forecasting models can account for the effects of economic shocks but they struggle to account for cultural and technological 'disruptions'. For example, we have seen large reductions in trip rates across the population since the turn of the millennium which may be associated with the widespread adoption of information and communication technologies but it has proven impossible so far prove this.

Cohort effects relate to differences in travel demand between groups in the population, usually focused on birth-cohorts. We have seen that the current generation (Millennials) drive much less than the previous generation (Generation X). Incidentally, we became accustomed in the past to the idea that over time each generation would drive more than the previous generation and (simultaneous with the Millennials phenomenon) we are seeing older people today drive more than previous generations. In either case, transport forecasting models are not designed to represent cohort differences.

It is analytically challenging to identify the separate role of age, period and cohort effects when explaining past change in travel demand. A good attempt at doing this by McDonald (2015) for the change in car mileage of young Americans between 1995 and 2009 found that lifestyle-related socio-demographic changes (age effects) accounted for 10% to 25% of the reduction in car mileage, while changes over time specific to Millennials and younger members of Generation X accounted for 35% to 50% of the reduction (cohort effects) and general dampening of car mileage travel that applied across all age groups (period effects) accounted for the remaining 40% of the reduction. With regard to the cohort effects, McDonald suggests the existence of "Millennial-specific factors such as changing attitudes and use of virtual mobility (online shopping, social media)".

Research is urgently needed in a UK context to investigate and identify age, period and cohort effects and to explain and interpret them. This will be needed to provide the understanding with which to develop new forecasting models that are more sensitive to social change.

For new forecasting models (or for non-quantitative ways of looking at the future), it is first necessary to acknowledge uncertainty and to accept the need to explore the future with different scenarios instead of point projections. Second, projections of future travel demand should not assume temporal stability in travel behaviour relationships (such as sensitivities of car mileage to personal income). Differences in travel behaviour relationships between birth-cohort groups (as well as differences depending on age and gender) should be considered as well as changes in these over time. This points to replacing the 'steady-state' transport models currently used, which assume that we only require future population composition and economic and transport conditions to make forecasts, with models which project the population forward over time, updating their circumstances, and predicting their travel demand taking account of cohort differences that persist over time.

*Kiron Chatterjee (24/02/17)*

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COMMISSION ON TRAVEL DEMAND

**Call for evidence : Understanding changing travel demand**

Peter Headicar, Associate, School of Built Environment, Oxford Brookes University

This submission addresses the first three questions of the Commission's Call for Evidence. It draws principally on research undertaken by myself and Gordon Stokes for the Independent Transport Commission analysing trends over the period 1995-2014 using National Travel Survey data. All references are to the resulting Technical Report unless otherwise stated[1]. This material is supplemented by additional work I have undertaken on the spatial dimension of travel behaviour.

Our research included an analysis of the extent to which changes in travel over the period were a product of changes in the composition of the population (eg by age, occupation or residential location) as opposed to changes in the behaviour of members of the individual categories. The results are reported in ch 6. The conclusion is that the bulk of the observed changes in travel in fact represent 'genuine' changes in travel behaviour.

It was not part of our brief to investigate the *cause* of these changes but in ch 7 we briefly review the likely possibilities. A feature of the 'peak-car' phenomenon in particular is the variety of contributory factors, not all of which are exerting an influence in the same direction.

1. ***Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?***

The presumption of stability in the determinants of travel is central to traditional forecasting approaches but this has been undermined by a number of unforeseen changes which began in the mid 1990s. Prior to this domestic travel in general and personal travel by car or van in particular had been growing broadly in proportion to the national economy. Thereafter there was – and remains - a decoupling of travel distance from both GDP and average household disposable incomes (Figure 7.1).

A second unforeseen change was a rapid rise in population[2]. This was due principally to growth in net international immigration (itself linked with EU enlargement). During the decade from 1995 England's population increased from 136,000 to 411,000 a year and continued at a similar rate thereafter. In aggregate this had the effect of offsetting the decoupling of travel from economic growth noted above but meant that after 1998 travel per head had in fact reached a plateau (Figure 1.1)

The economic recession of 2008-9 caused a dip in total miles travelled but, unlike the recessions of previous decades, there was not a full recovery in subsequent years. In fact,

with continuing growth in population travel per head entered a period of slow decline. By 2014 it had reached a low point of 94% of its 1995 level.

A third unforeseen change from the mid 1990s was that continuing increases in overall rates of licence holding and car ownership did not translate into increases in car use (Figures 3.1 and 2.5). In fact, compounding the overall decline in travel per head, car driver mode share actually *fell* by three percentage points during the period.

This seemingly paradoxical outcome was due primarily to the fact that the growth in licence holding and car ownership occurred disproportionately amongst older women and lower income households – groups with per capita car use well below the average. (Figures 4.6, 4.2, 5.2 and 5.8)

Conversely there was a sharp decline in company car ownership amongst the highest income households groups and a halving in the associated per capita mileage (Figures 5.2 and 5.9). Most remarkable of all was a pronounced fall in licence holding and car ownership amongst young men aged 17-34, again with a near halving of their per capita mileage over the period (Figure 4.2).

A final unforeseen change which can be noted here is the reversal of a long term decline in rail travel and its subsequent doubling over the period from 1995 to 2014. A particular feature of this growth is that it exceeded the growth in disposable incomes and (during the most recent decade) in rail fares (Figure 7.5). This is in marked contrast to the trend in car driver travel which followed a trajectory well below the levels of incomes and car running costs (Figure 7.4).

The 'switch' to rail travel is one of the factors contributing to the overall decline in car driver mode share. However the scale of this needs putting into perspective. Even amongst members of the highest income households their increase in rail travel only represents a fifth of their reduction in car driver travel.

**2. *How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain change?***

Analysis by trip purpose (Table 2.1) shows that within the overall decline of 7% in per capita travel (1996/98 to 2012/14) individual categories vary between +24% (escort education) and -40% (sports participation). Hence it is not necessarily the activities (purposes) for which travel is undertaken that may have changed but rather the *mix* of activities that people choose to engage in, and how. Significantly the four main trip purposes - commuting, visiting friends at home, shopping and business - have all experienced substantial reduction and together account for almost all the overall decline.

In NTS reports measures of travel are customarily presented on a per capita basis. However this does not enable the source of change to be identified. Hence in our research travel by purpose was examined as the product of three factors:

- Change in the proportion of the population making trips of the particular kind (so-called 'trip-makers', calculated on the basis of NTS respondents recording one or more such trips during their travel diary week)
- Change in the frequency with which trip-makers make these trips
- Change in their average trip distance

The results of this form of analysis are shown in Table 2.2

Thus in the case of commuting there has been a reduction of 10% in the proportion of the population making such trips and a 9% reduction in trip-makers' trip frequency. These are offset by an increase of 8% in their average trip distance resulting in an overall reduction of 12%. This is consistent with other NTS data indicating an increase in the proportion of people working permanently at or from home and an increase in the proportion and frequency with which those commuting to a regular workplace occasionally work at home[3]. This trend illustrates an impact of ICT on travel (one of the possible causes of change noted in ch 7). Whilst not strictly 'causing' home-working it has plainly facilitated it.

More generally Table 2 shows differences in the direction of change (+ and -) between individual purposes in the proportion of people making trips and in their frequency. However in relation to trip length there is a near universal trend towards increased distance. Historically this might have been attributed to increased car availability and to counter-urbanisation. In the contemporary context however it seems likely to reflect greater discrimination in the decision to travel. In the case of shopping for example more people will purchase rudimentary items on-line and have them delivered (again NTS evidence supports this). Shopping or 'browsing' trips may be reserved for more discretionary items (possibly combined with social or recreational purposes) at places a greater distance from their home.

Changes in trip-making are also analysed for individual age/gender groups (ch. 4). These reveal differences which highlight the complex mix of factors contributing to overall travel outcomes. For example in relation to commuting participation by men aged 35-59 has fallen by 13% and average trip distance has increased by 9% (Table 4.7). For women of the same age however participation is unchanged and average distance has increased by 30% (Table 4.9). These differences are largely explained by changes in occupation and car availability amongst the female group (Figures 6.8 and 4.21) although their average trip length remains only two-thirds of men's.

### 3. *How do these (changes in travel demand) vary spatially? Are there distinctions between central, suburban and rural areas and are there differences between cities?*

It is extremely difficult to classify places in a way which captures all the main features likely to be linked with travel behaviour and on which national data is available. Three different metrics have been used :

- Settlement size (the population of built-up areas as defined in Census output)
- Population density (here referring to NTS respondents' post-code sector)
- ONS classification of lower tier local authorities (based on cluster analysis of socio-economic variables)[4]

Each of these has its limitations and there is considerable overlap between them. None incorporat additional characteristics which have been shown to differentiate behaviour between otherwise similar places, for example distance from principal external urban centre and proximity to strategic transport routes[5]. Nor do they embrace differences of urban form and transport operation resulting from local policy which have had the effect of encouraging or discouraging car use. These and other factors mean that in practice there will be considerable variation between places within a single spatial category, however defined.

Using categorisations by population density and settlement size Charts 1 and 2 below show the variation in miles per adult per year for all modes and for car/van driver travel for

**Chart 1**

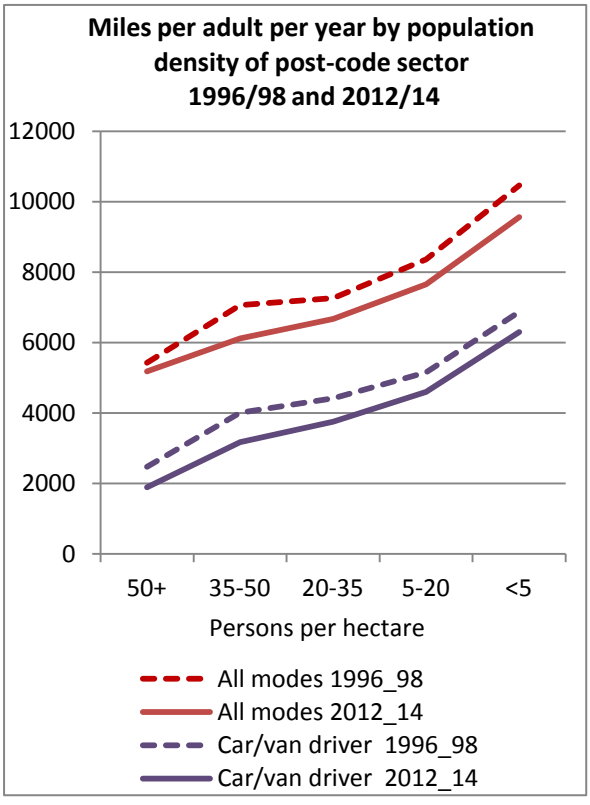
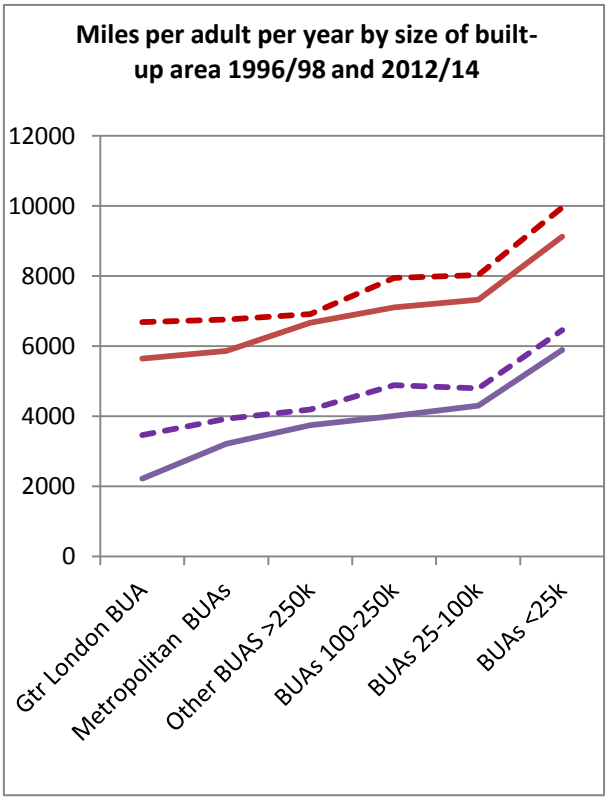



**Chart 2**



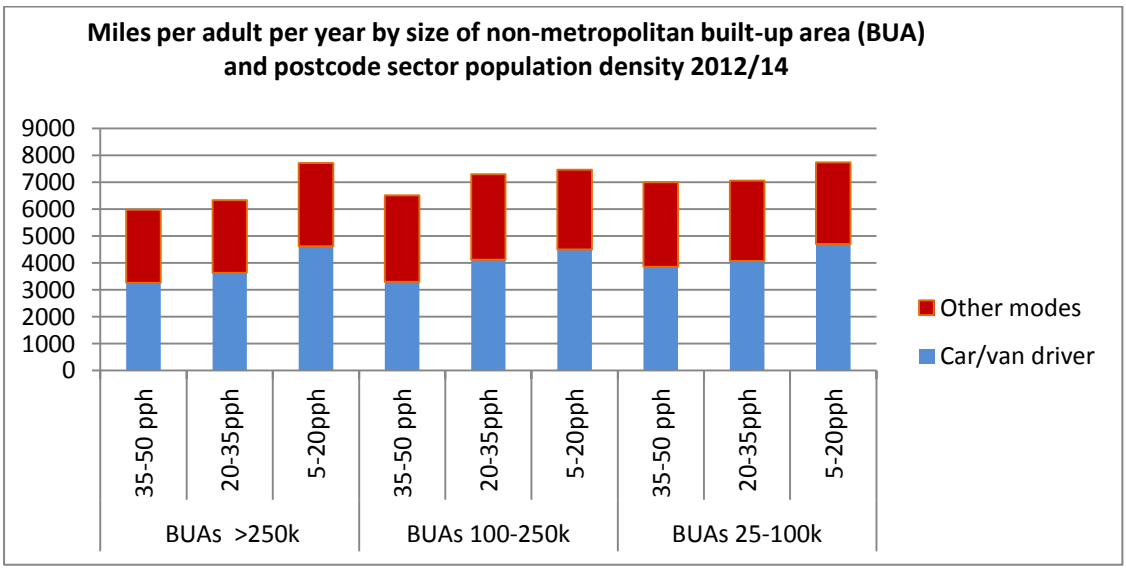
1996/98 and 2012/14. The overall picture is unsurprising. Higher local densities and larger urban areas are associated with less travel and less car use. (Higher densities typically imply proximity to urban centres, shorter distances to local facilities, better opportunities for walking and public transport and more restrictions on parking and car use. Larger urban areas (as well as having higher densities) imply greater self-containment for work and other more specialised trip purposes.

All categories display a similar reduction in travel and car driver mileage over the period. However this apparent symmetry may be misleading in that proportionally the reduction is much greater at the more urbanised end of the spectrum. For example car driver mileage has reduced by 24% in the highest density areas and by 36% across the Greater London BUA but by only 8% and 9% in the least dense areas and smallest settlements. This highlights an important challenge in terms of reducing car use and its adverse impacts nationally – it may be easier to achieve in the more urbanised areas but the biggest volumes are to be found elsewhere.

The Commission's call asks for evidence about differences between parts of urban areas. Chart 3 below compares per capita travel between the three main density bands found in non-metropolitan urban areas greater than 25,000 population (Figure 5.19). These may be equated with their inner, middle and outer suburban areas.

As can be seen there are differences as one would expect but they are modest. The difference between density bands is less in the smaller towns, probably because they occupy a smaller area and hence differences in location (eg distance from the town centre) are less. This highlights another important feature of the national situation. Across much of 'middle' England (the categories shown in the chart comprise 31% of the population) the spatial differences in travel behaviour are relatively small, local factors aside.

**Chart 3**



The Commission also asks for evidence about differences between cities. This begs the question of how 'cities' are to be defined! Local government administrative units are one possibility but their boundaries are not consistent with respect to built-up areas. (For example Leeds includes substantial small town and rural components whilst Bristol is confined to the core city). On the other hand what are defined as 'built-up areas' do not necessarily distinguish between functional entities. Leeds and Bradford for example are likely to be regarded as separate cities but both are officially defined as part of a larger 'West Yorkshire Built-Up Area'. A bespoke research exercise would be needed to overcome these difficulties.

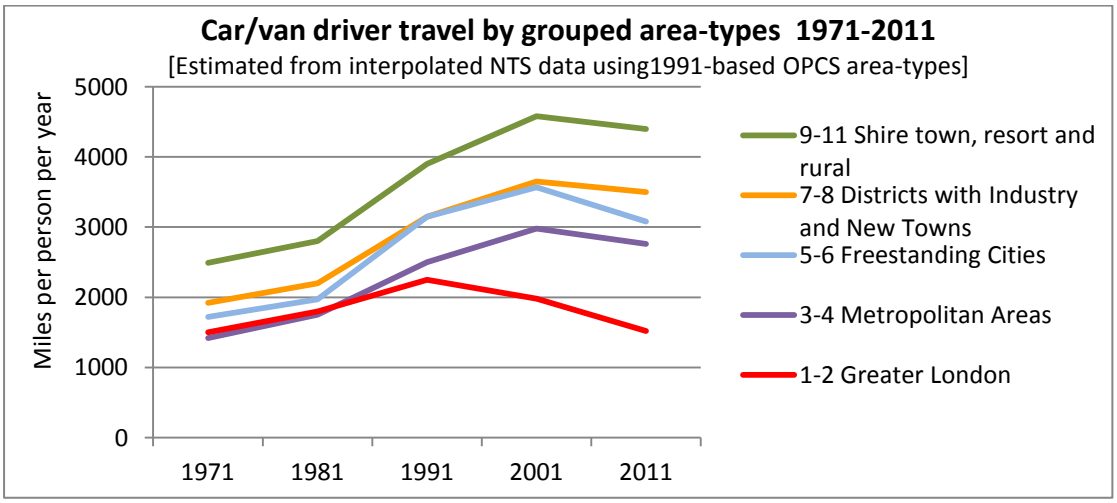
Notwithstanding inconsistencies between local authority units Table 1 below shows the range of towns and cities outside London with administrative populations greater than 100,000 classified by ONS area type. (By definition this means that they have socio-economic similarities). The percentage of commuters travelling as car drivers in 2011 is used as the metric to identify the lowest, median and highest authority in each group.

**Table 1 Car/van driver commuter mode share and population (2011) by ONS 2001 local authority area-type, excluding London**

| Area type (number of LAs) | Lowest | Median | Highest |
|---|---|---|---|
| Regional Centres (15) | Brighton & Hove<br>39.9% (273k) | Portsmouth<br>53.5% (205k) | Lancaster<br>62.2% (138k) |
| Centres with Industry (17) | Manchester<br>46.3% (503k) | Bradford<br>62.2% (522k) | Kirklees (Huddersfield)<br>68.0% (422k) |
| New & Growing Towns (8) | Ipswich<br>57.7% (133k) | Medway (Chatham)<br>65.7% (264k) | Milton Keynes<br>68.8% (249k) |
| Industrial Hinterlands (15) | Hull<br>53.9% (256k) | Sunderland<br>62.0% (275k) | St Helens<br>70.9% (175k) |

The classification of local authorities has also been used to identify the spatial variation in per capita driver mileage more generally over successive decades since 1971[6] – see Chart 4 below. This illustrates both the widening range during the period of national growth (to 2001) and – as remarked on above – the different rates of decline since.

**Chart 4**



The changes between 2001 and 2011 have been examined more closely using Census data and the ONS 2001-based classification of area-types[7]. This leads to the conclusion that distinctive types of change are occurring in contrasting types of places. Chart 5 below illustrates this with reference to change in commuting mode share. (Note that in the chart the area-types are ordered left to right by reducing population density). At either ends of the urban/rural spectrum the divergence already evident in car ownership and use is becoming even more pronounced but the situation amongst intermediate categories is more complex, thus:

London area : Very large reduction in car driver share (from an already low base); replaced mainly by public transport and by cycling in inner areas

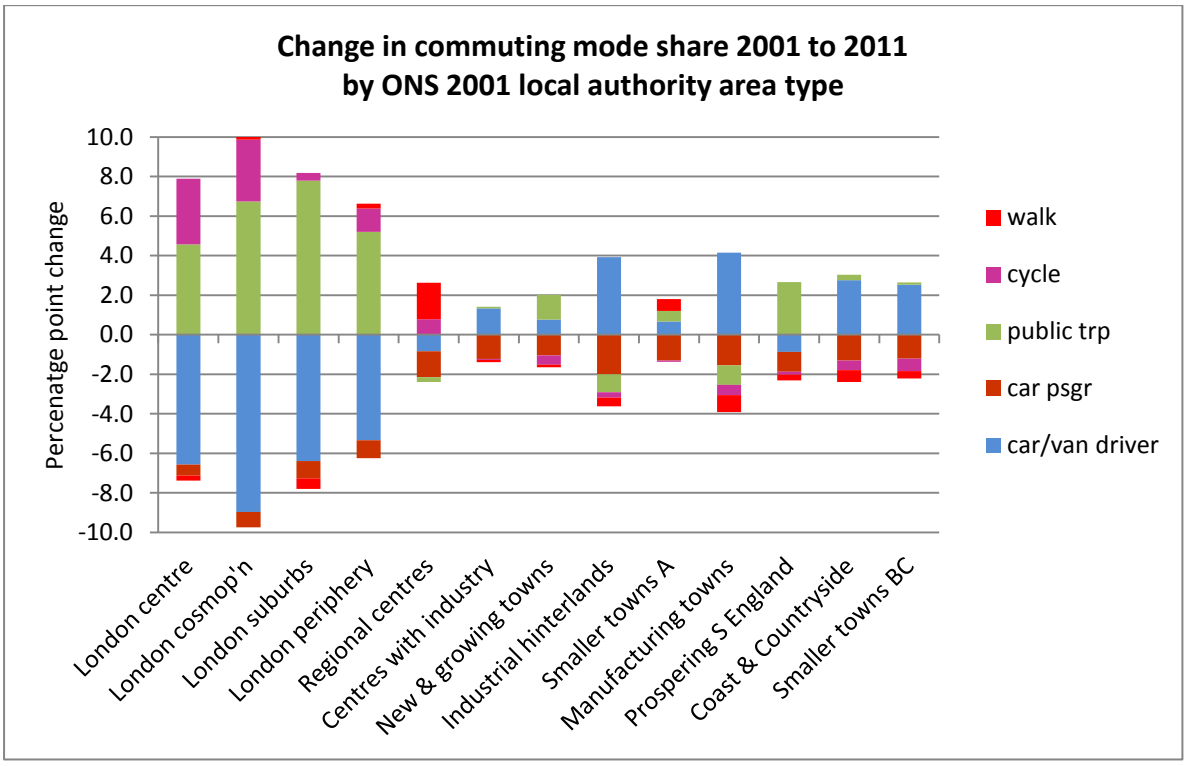
Provincial centres and main shire towns (Smaller towns A) : Little change in car share; small reduction in car passenger; small increases in non-car modes

Industrial Hinterlands and Manufacturing Towns (confined to the Midlands and Northern England, traditionally areas of lower car ownership) : substantial increase in car mode share at the expense of all other modes

Greater South-East beyond London area (New & Growing Towns and Prospering Southern England); mostly high income/ high car owning area but public transport gaining additional mode share at the expense of car use

Smaller shire towns, coastal and rural; already high levels of car driving continuing to increase, replacing car passenger

**Chart 5**



The higher levels of population increase over the last two decades coupled with divergent travel trends in different types of area prompts the question of whether the changing spatial distribution of the population is having a material effect on aggregate travel volumes. In our report for the ITC we noted that the erstwhile net movement of population from cities to smaller towns and rural areas (so-called counter-urbanisation) had actually gone into reverse – an aspect of the 'urban renaissance'. Over the decade from 2001 to 2011 London, the provincial conurbations and other built-up areas with more than 250,000 population collectively increased their share of the national total by four points to 50% (Figure 6.10). During this time per capita travel nationally fell by 755 miles a year and car driver travel by 550 miles. These reductions were 80 and 65 miles a year greater than would have occurred if the spatial distribution of the population had remained unchanged as at 2001.

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**Notes and References**


1. Headicar P. and Stokes G. (2016) *On the Move 2 : Travel Trends in England 1995-2014* Technical Report Independent Transport Commission London Available at www.theitc.org.uk
2. Strictly a numerical adjustment to an input variable doesn't of itself undermine the notion of stability in relationships. However in this case the scale and nature of the change (which altered both the social composition and spatial distribution of the population) undermined the basic assumption of a 'business as usual' trajectory
3. Headicar P. *Changes in work-related travel : England 2002-2012* Unpublished paper June 2015
4. Details of this classification based on 2001 Census data , including a map of local authorities at group level referred to in this submission is available at http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/geography/products/area-classifications/ns-area-classifications/index/index.html
5. Headicar P and Curtis C (1998) The location of new residential development – its influence on car-based travel, in Banister D (ed) *Transport Policy and the Environment* London, E&FN Spon
6. Headicar P (2013) The changing spatial distribution of the population in England : Its nature and significance for 'peak car' *Transport Reviews* **33**(3) 310-3
7. Headicar P. *Contrasting Places : Diverging Travel Behaviour? – A Spatial Analysis of Population and Travel Trends in England* World Conference on Transport and Land Use Research (WSTLUR) June 2014 University of Delft The Netherlands

RAC Foundation

Mobility • Safety • Economy • Environment

# RAC Foundation's Response to the Commission on Travel Demand's Call for Evidence: Understanding Travel Demand

## February 2017

### 1. Introduction

1.1 The RAC Foundation[1] is an independent transport policy and research organisation which explores the economic, mobility, safety and environmental issues relating to roads and their users. The Foundation carries out independent and authoritative research with which it promotes informed debate and advocates policy in the interests of responsible road users.

1.2 The Foundation's interest in better understanding travel demand is its implications for future levels of mobility, road traffic conditions, road safety and the environmental impacts of roads and their traffic; and the consequent need for changes in regulation, pricing, technology and physical infrastructure needed to accommodate future demand levels. Whilst the motorist and road use are the focus of the Foundation's interest clearly a wider view of demand must be taken because many 'demand drivers' apply to a range of transport modes and there is some overlap between the different means of road transport and between road and rail.

1.3 Defining 'travel demand' is not easy as it is circumstantial varying in nature by time, location, user type, price and service levels[2]. In using the term 'demand' therefore it is important to bear in mind that its manifestation is contingent on the prevailing travel conditions and particular circumstances of that sector of the travel market.

1.4 This response relies heavily on a series of studies carried out by or for the Foundation which are listed in the Sources section. Identification of which studies underpin which of the points made have not been systematically made, to save time and space, though a substantial source list is annexed.

1.5 Standing back from work specifically commissioned by the Foundation, it might be useful for the Commision to consider the following points:

- The relationship between the cost of travel and travel demand is evident, but far from linear. Making bus travel cheaper is not going to attract wealthy Londoners from their Range Rovers. In particular is it important to look at the cost of travel

[1] For further information about the Foundation see http://www.racfoundation.org/.
[2] See for example McNally 2016.

relative to other costs, specifically housing. This impacts most obviously on patterns of rail commuting in the South East;

- The only thing we can say with absolute confidence about the future is that it hasn't happened yet. There will be unexpected, unpredicted disruptors. The impact of the autonomous road vehicle on travel patterns thirty years hence is, today, unknowable, and we should not delude ourselves otherwise; and so
- Forecasts should always be presented as ranges, not point or average results, with some indication of probability. This is frantically difficult for politicians to manage – neither the media nor the parliamentary select committee wants to have to manage more than a single number, or, at most, two – what's it going to cost, and what's the benefit going to be? Academia has an important role to play in helping politicians, officials and officers navigate these choppy waters.

## 2. The estimation and forecasting of travel demand has changed over the last fifty years and will continue to do so.

2.1 Prior to the Second World War, and for some years thereafter, those who attempted to establish and forecast travel demand (typically infrastructure planners) relied largely on measuring existing usage and using trend projections to estimate future levels[3]. This started to change in the 1960s with work by individuals like John Tanner[4] and the teams carrying out the new, computer aided, metropolitan transportation studies[5]. From this evolved fairly standard sets of procedures (both aggregate and disaggregated) for estimating future personal travel demand based on a range of external factors such as population, households, employment, income, car ownership etc. With these models new features such as benefit/cost analysis of alternative plans were also being incorporated.

2.2 The range in commercial and other factors that affected changes in van and lorry traffic have consistently confounded attempts to develop similar procedures and a mixture of trend, demand elasticity and wider industrial performance models have been used. Whilst these have worked quite well for true freight movements (mainly lorries) the diversity of purposes for which vans are used is such that there has been little success in reliably forecasting future van activities.

2.3 Of late these procedures appear to have been performing less well and there is perceived to be a need for new methods which take into account factors that we are learning about, but which are ignored by these traditional methods. Before dismissing these methods completely it is worth considering why they are no longer serving the transport planning community adequately.

2.4 When the forecasting regime typified by the four stage transport model developed in the 1960s[6] and into the 1970s the raw effects of rising income and car ownership,

[3] See for example Hall 1963.
[4] Tanner 1961.
[5] E.g. Freeman Fox & Associates 1968.
[6] Martin Memmott & Bone 1961.

changing population and employment structure were so powerful that they dominated the expected growth in travel demand[7]. Whilst other factors were also playing their part, these powerful primary factors took centre stage in the forecasting procedures and outcomes. For example whilst the number of households with one or more cars increased from 38% in 1964 to 55% (45%) in 1974[8], between 2000 and 2010 this grew and order of magnitude less from 72% to 75% (4%) where it remains today[9]. As a consequence what were second order factors forty years ago now become more significant; especially where they are varying to greater degrees than previously.

2.5 There is a logical progression from being aware of previously ignored forces to being able to specify and then measure them and finally incorporate them in formal estimation procedures; and recent work[10] has revealed a range of forces at work but not all of which are able to be formally introduced into contemporary travel analyses. The DfT's recent road traffic forecasts have made[11] impressive efforts to expand the range of factors used in its forecasts, to give more disaggregated results and to cope with some uncertainties by analysing a range of scenarios. The fact that this does not go the whole way to representing some of the more recently evident factors means that they should be qualified, rather than dismissed.

## 3. Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?

3.1 Recent trends that were not anticipated, or for which the pace was significantly different from that expected, are listed below. Some of these are the result of weaknesses in the travel forecasting methods whilst others were caused by external 'surprises' such as the 2008+ recession and public policy changes.

- The slowing down of car traffic growth from 2%pa in the mid-1990s to a fall of 3% between 2007 and 2010. However, over the last two years growth has recovered to 1⅓%pa[12].
- The decline in urban car traffic by 2½% over the last twenty years[13].
- The two thirds increase in van traffic over the last twenty years[14].
- The doubling of national rail passenger traffic since the mid-1990s[15].
- The strong growth of intermodal freight since the beginning of the 2000s[16].

[7] See for example Bayliss 2008.
[8] DoE 1976, table 39.
[9] ONS 2016a.
[10] E.g. Le Vine & Jones 2012.
[11] DfT 2015.
[12] DfT 2017a.
[13] Ibid.
[14] Ibid.
[15] DfT 2016b.
[16] Ibid.

- The continued strong growth in London Underground traffic since the beginning of the 2000s (although growth was expected – not by over 50%[17]).
- The continued decline of bus use outside London – a 4% fall compared with a 90% increase in London[18].

3.2 Not all changes in travel demand are included in the traditional forecasting procedures but may also be noteworthy. Much was made in the 10 Year Plan of trebling cycling between 2000 and 2010, in practice however cycling has grown little (London again being an exception) and remains at around 1% of all personal travel. Changing economic and social patterns have increased travel outside the peak – especially in the late evening – with implications for public transport services. In future these elements of the travel demand scene may grow in importance and need to be reflected some way in the formal demand estimation procedures.

## 4. How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain change?

4.1 Research for the Foundation has identifies a range of factors that go some way to explaining why recent trends have not followed expectations and these are listed below. However first it is important to point out that traditional demand forecasting methods take little or no account of economic cycles. Whilst the effects of these have been evident (ex post) from recent cycles, predicting the timing and amplitude of these is very difficult. Some 'trend failures' have been a result of unexpected changes in economic circumstances and these are likely to continue to dog travel forecasting.

4.2 Some reasons for changes in travel demand derive from new social and economic behaviours. Others lie with the operation of the transport system itself. Whilst these are related in real life (e.g. increased demand for rail triggering better services which stimulate demand further) for the purposes of this paper they are identified separately.

4.3 It is not possible to be definitive about the phenomena that have not been adequately accounted for in 'traditional forecasting' for two reasons. Firstly some have been taken account of either implicitly in calibration, or explicitly in behavioural functions - but not necessarily accurately or to a sufficient degree. Secondly 'traditional forecasting' includes a wide range of techniques, some of which ignore the phenomena listed below but others do not. However from the Foundation's work these identified in the following eight paragraphs appear to be worthy of consideration.

4.4 The have been some changes in land and overall population trends including:

- There was a substantial and higher than expected increase in Britain's population from 56.4 in 1995 to 63.3m in 2015[19] with a quadrupling of net international

[17] DfT 2016c.
[18] DfT 2016d.
[19] ONS 2016b

migration since 1997. People born outside the United Kingdom tend to use cars less, an effect which is seen most in the 20–39 age group in which migrants are concentrated.

- There has been more development on previously developed land and often at higher densities than previously as a result of stricter and 'sequential' planning policies. The average density of new residential building in England was stable throughout the 1990s, then increased year-on-year from 25 units per hectare in 2001/2 to 43 in 2007/8, and has since plateaued at this higher level[20].
- An increased concentration of people and jobs in London and the South East. For example between mid-2014 and mid-2015, of the 470k increase in England's population 57% was in London, the South east and the East of England – and 29% in London alone[21].

4.5 There have been a number of socio-demographic changes with important implications for travel demand including:

- There has been higher proportion of older people, who are better off, and drive more than their predecessors (especially women[22]). The greater ease of driving modern well equipped vehicles has aided this significantly.
- The gap between the proportion of men and women who drive is closing (80% of adult males in both 1990 and 2015 but 50% increasing to 68% for adult females) with women's share of car/car traffic increasing from 38% in the mid-1990s to 45% today.
- There has been reduction in the number of young people that are economically active.
- It has become increasing difficulties for young people in being able to move out of the family home and adopt radically new mobility patterns.
- More young adults have been migrating to Britain's metropolitan areas where car ownership is less attractive and necessary.
- Fewer young people are learning to drive and buying a car, as a result mileage driven by young adults has trended consistently downwards (-30%), and their car passenger travel has also fallen. Higher learning and insurance costs are undoubtedly a factor in this.

4.6 Communication technology has improved enormously over the last two decades, especially with the expansion of the Internet and the availability of smartphones which have had implications for travel demand including:

- Fewer people making physical shopping journeys and more home deliveries and 'click and collect'. The internet and improved 'fulfilment' schemes by retailers and their agents have been the driving force behind this trend. However more generally - after accounting for household income, socio-demographics and other baseline

[20] DCLG 2016a and 2016b.
[21] Ibid
[22] DfT 2016e.

effects, - use of the Internet was found to be associated with a higher probability of holding a driving licence.

- On average, using the Internet was associated with nearly 500 more driving miles per year than not being an Internet user. What is more, beyond 5 hours per week of online activity we found a strong negative relationship between Internet use and driving mileage (i.e. the association with driving weakened from 5 hours upwards, until by 20 hours a week there was no positive association any longer).
- Internet availability has also had implications for business practices expanding markets and supply chains as well as substituting some electronic transactions for physical journeys.
- High quality 'on the move' communication has had implications for travel and allowed some types of travel (especially longer train journeys) more productive.

4.7 Travel behaviours have also changed sometimes in unexpected ways over this period including:

- In general, very little of the observed aggregate change in car and rail travel is accounted for by the ongoing changes in the proportions of the population that fall in each age group, or that live in different types of area; most are due to changes in travel behaviour within groups, caused by external factors.
- Average car driving mileage per head of population has changed little in Britain over the ten-year study period, but this masks large differences in trends between men (whose driving mileage has decreased) and women (whose driving mileage has increased); the largest drop has been for men in their 20s, whose average car mileage fell by about 2,000 miles per year.
- Most of the reduction in mileage by men (except for those in their 20s) can be accounted for by a sharp fall in company car use; this seems to be linked to the large increases in taxation on fuel provided for private use. The reduction in company cars was from 1.6m in 1999/00 to 940k in 2015 – company cars travel about 2½ times the distance of their private counterparts[23].
- There has been a sharp increase in rail use which has grown most rapidly for business purposes – it has nearly tripled – and there is some evidence of a partial shift of business travel from company car to rail for men. The growth in the rail market seems to be fed by 'new entrants' rather than by increased use by established patrons.
- More people have travelled abroad for leisure and business which will have replaced some domestic journeys. Between 1995 and 2015 there was a 74% (24.1 million) increase in overseas visits by UK residents for holidays of visiting friends[24].

4.8 The structure of the economy has also been changing with more service jobs which do not need to be so place-based, and electronic communications allow the potential of the

[23] DfT 2015f
[24] ONS 2016c.

mobile office to be realised and increasing working from home which has now grown to over 10% (mainly, but not all the time) which has eased peak personal travel demand.

4.9 The transport system itself has changed and the effects of these changes has not always been incorporated in travel demand forecasting. These changes include:

- Increasing difficulties in finding a parking space in urban areas[25].
- The expansion of national rail service by 40% since 1997/98 and improvements such as the WCML modernisation and Thameslink.
- Improvements in London Underground services by a third since 1997/98[26] including the opening of the Jubilee Line Extension.
- New forms of car access have emerged – car clubs and car sharing. However so far these remain as niche markets with little impact on general car traffic.
- Aspirations to reduce road traffic congestion[27] have not materialised and of late concerns about congestion are become substantial[28]. This must be having an impact on the propensity of some groups to drive and perhaps even where they live.
- Following escalation in the 1990s, the freezing of fuel duty in cash terms since March 2011[29] (Since 2000 motoring taxes payed per vehicle mile have fallen by 28%).

4.10 Other changes to the transport system which have not had the effect on travel demand that some expected has been the expansion of light rail outside London where despite a doubling in route mileage[30] patronage still amounts to a little over 2% of bus travel[31]. The continued fall in bus use outside London has also been an unexpected disappointment. In the twenty years to 2015/16 this grew by 90% in London but fell by a quarter in the rest of metropolitan England and a 15% reduction in the rest of the country. It would be surprising if deregulation had not been a major contributor to this difference and if half of London's bus traffic growth from the mid-1980s had been experienced in the Mets and a quarter in the rest of the country, there would now be a billion more local bus journeys a year outside the capital, and local bus per capita trip rates would be 65 journeys a year compared with the current 48.

4.11 Understanding the underlying reasons for van use and how these have changed remains one of the most difficult areas for transport analysts. Factors contributing to the strong growth in van ownership and use over the last two decades probably include:

- A growth in home and office services such as such as cleaning, gardening, equipment repairs and maintenance; promoted by higher incomes, more sophisticated domestic and work equipment and a reduction in 'self-service' activity.

[25] Daily Telegraph 2017.
[26] LT 1999 and DfT 2016c.
[27] E.g. in the 10 Year Plan –congestion reduced below current levels particularly in large urban areas and 3% on the strategic road network
[28] DfT 2017b; motorways up from 22% to 37% between 2011 and 2015 and 39% up to 55% in towns and cities.
[29] ONS 2017.
[30] DfT 2016g
[31] DfT2016d and DfT 2016h.

- An increase in mobile sole traders, aided by much improved roving telecommunications, for whom a van is essentially their mobile workshop/store.
- An increased need for tradesmen to carry heavy and specialised equipment for which other forms of transport are not suitable.
- An increase in home and office deliveries as a result of the expansion of internet trading – although perhaps not as much from Internet shopping as commonly supposed[32].
- A growth of 'just in time' transactions from replenishing a restaurant's wine stocks during trading hours to sourcing building materials as needs arise.
- Lower costs of van ownership and use

Whether it will be possible to develop formal demand models which allow for all these factors is a moot point but it should be worth at least trying to get a better qualitative feeling for their relevance.

**5. How do these vary spatially? Are there distinctions between central, suburban and rural areas and are there differences between cities?**

5.1 The work carried out for the Foundation has included little that differentiates between different regions and types of area/settlements, timing of trends and travel patterns What can be said in response to this and the next question is therefore limited.

5.2 The most obvious spatial distinction is between London and the rest of the country – especially the smaller towns and rural areas. London has always been different but has become more so in terms of its transport landscape. The high housing costs in London and to a lesser extent in cities like Leeds, Birmingham and Manchester have meant that the phenomena referred to in paragraph 4.5 are, almost certainly more evident elsewhere there than in the in the rest of the country.

**6. How do they vary over time? Are there particular times in the week where demand has changed or seasonal variations which have emerged?**

6.1 There is anecdotal evidence of evening visits to pubs and clubs lengthening with the relaxation of licensing hours – most recently in 2005 resulting in increased late night/early morning travel. The proportion of goods vehicle traffic has increased at the weekends on motorways and in urban areas[33]. During the day there has been a small increase in the proportion of early morning (03.00 – 07.00hrs) traffic and a slight lengthening of the evening peak[34]. These changes are presumably a result of trading practices (including increased Sunday trading), moves by HGV operators to avoid weekday congestion and

[32] Braithwaite 2017.
[33] DfT 2016i and DfTj.
[34] DfT 2016k.

possibly the increase in foreign HGVs using Britain's roads (a more the fourfold increase over the last twenty years[35]).

## 7. What methods can be used to incorporate greater uncertainty[36] in demand? Have they been deployed and to what effect?

7.1 The first step in dealing with uncertainty in estimating demand is to reduce unnecessary errors in the forecasting procedure by stringent control of data quality, thorough calibration and validation of the demand models and ensuring that as many quantified variables are incorporated in the estimation procedures are practicable.

7.2 Secondly there should be a qualitative assessment of the nature and scale of the key uncertainties and their ranges incorporated into alternative set of scenarios for formal evaluation. This will allow combinations of uncertainties to be tested and probabilities assigned to variations from the central forecasts.

7.3 Thirdly, no matter how refined the formal estimation process is made, there will remain factors which it is unable to include: these should not be ignored but identified in a parallel narrative to enable the decision maker to make appropriate allowances for these. It may be possible for some of these factors to carry simple 'what if' calculations to get a feel for the orders of magnitude involved.

7.4 Finally demand estimates need to be updated at regular intervals to take into account both changed circumstance and the opportunities to develop and refine the estimation procedures.

7.5 The best example of which the Foundation is aware of recognising and treating uncertainty in demand estimation is the recent work in the Department for Transport in its National Road Traffic Forecasts[37].

[35] DfT 2016l.
[36] It is assumed that this does not include 'risks' which different in nature and should be dealt with separately.
[37] E.g. DfT 2015.

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# Call for evidence: Understanding Changing Travel Demand

**Sustrans submission to the Commission on Travel Demand, February 2017**

## Introduction to Sustrans

1 Sustrans makes smarter travel choices possible, desirable and inevitable. We are a leading UK charity enabling people to travel by foot, bike or public transport for more of the journeys we make every day. We work with families, communities, policy-makers and partner organisations so that people are able to choose healthier, cleaner and cheaper journeys, with better places and spaces to move through and live in.

2 In this submission we provide feedback primarily from the perspective of walking and cycling. We have substantial experience in evidencing the benefits of investment in these modes. Sustrans has along track record in monitoring cycling and walking activity and in evaluating the impact of interventions delivered in support of walking and cycling. We hold extensive data resources that could help to support the work of the commission.

3 We hold that travel demand is a highly complex interaction across a range of themes and disciplines, extending well beyond transport. Demand forecasting tends to be constrained by 'current condition' assumptions; but we would also contend that where more ambitious modelling is attempted, the 'future world' assumptions are not based on realistic expectations.

4 In this submission we respond to the questions posed by the Commission largely (but not exclusively) from the perspective of walking and cycling; we illustrate points where we reasonably can, or, more frequently, we cite data sets which may prove informative in the context of those points; and we draw out the key conclusions that we want to emphasise.

## Response to consultation questions

- **Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?**

5 Most obviously, in the context of cycling, we can point to a growth in levels of cycling that Government sources failed to anticipate throughout the past two decades. For example, Tempro data inputs were based on forecasted decreases in levels of cycling (I am uncertain whether or not this is still the case). The reasons are straightforward enough – observations suggest that cycling declined over the decades up to the start of the 1990s, so the continuation of the observation-based trend line simply followed the set pattern.

6 However, this fails to acknowledge the complexity of factors that have influenced travel patterns throughout the past twenty years, and for twenty years before that. Most fundamentally, investment is the stimulus for change. So pre-1990, when investment in cycling was negligible, levels of cycling fell. Investment was much more heavily concentrated in cars, and patterns of travel reflected this. Since 1990 more investment in cycling saw levels of cycling grow in some

locations. But investment is so modest (particularly relative to investment in other modes) that changes remain limited in most places.

7 In terms of walking, patterns are less clear. But there is plenty of evidence to suggest that where investment supports walking, levels of walking increase.

8 In the context of this part of our response we would like to flag up the following material:

- Sustrans modelling work on delivering the Cycling and Walking Investment Strategy, which uses measured responses to intervention to forecast the costs of achieving the Government's target on walking and cycling – http://www.sustrans.org.uk/sites/default/files/images/files/Achieving%20the%20Government%27s%20targets%20for%20cycling%20in%20the%20Cycling%20and%20Walking%20Investment%20Strategy.pdf, http://www.sustrans.org.uk/blog/what-will-it-take-achieve-govs-bold-aims-cycling-and-walking

- Sustrans' Bike Life reports, which suggest a considerable 'latent demand' for cycling that current transport planning often fails to recognise, and identifies some of the barriers – http://www.sustrans.org.uk/bike-life/overall-survey

- Our response to recent Webtag consultations also carries some relevance here – http://www.sustrans.org.uk/blog/valuing-transport-schemes-high-risk-low-returns, http://www.sustrans.org.uk/blog/how-do-we-value-travel-time

9 Further, we have recently conducted some exploratory work on travel trends in Scotland. This work is not yet published (we can make this work available to the Commission). But the observations make for some interesting reading. Notably:

- The number of trips being made by car is showing a recent increase after a period of reduced car travel; the overall share of trips that are made by car is falling; the proportion of people driving every day is similar to the figure for ten years ago, but lower than a more recent peak; the proportion of licence holders among several age groups is decreasing; licence holding by women is growing whilst the proportion of men with driving licences is stable or falling

- The share of all trips that are made by walking has grown substantially in recent years; the increase in walking is not attributable to walking to school; speed and volume of traffic are deterrents to cycling; the levels of walking and cycling on the National Cycle Network are growing markedly.

10 We comment specifically on the predict-and-provide paradigm later in the text.

- **How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain change?**

11 The list of parameters that influence travel demand is huge. Maybe they can be broadly grouped into the personal and domestic determinants, response to society and community, and macro-level drivers.

12 At the personal level, we can suggest that travel complexities (e.g. moving family members to multiple different locations), workplace constraints (time or arrival and departure), and income would be key factors. These might be set against the increased recognition of the contributions of walking and cycling to personal health, the use of leisure time, and individual responses to perceptions (in cycling and walking terms, 'normalisation'). There are also issues around age, gender (we have a useful blog on this theme due for release any day now), life-stage, etc.

13 In terms of society and community, there are a whole host of issues that could elicit what we might call a positive response, such as air quality and participation and engagement, and a set of factors that might make choosing cycling or walking more challenging, such as issues around local environments and perceptions of safety/security.

14 At the macro level the most obvious drivers might include economic and technological changes. But other challenges such as climate change ought to be taken into account too.

15 These feels like a rather non-substantive answer to the question posed. But the reality is that the palette of influences is so extensive, and the interactions are so difficult to disentangle, that it is difficult to sensibly articulate.

16 Sustrans' response to this challenge is to attempt to design our interventions around a 'socio-ecological model' that seeks to address the cultural/ community, environmental and individual components that affect travel choice. In practical terms, this means that ideally an intervention would be part of a package that engages a community, changes an environment, AND supports individuals. Our approach is described in a little more detail later in the text.

17 The broad premise of our approach is distilled from evidence collected around interventions. Particular examples of relevant data resources and evidence of impact include:

- Bike Life, as above, which reveals much about attitudes to and perceptions of cycling in the seven participant cities - http://www.sustrans.org.uk/bike-life/overall-survey
- Travel behaviour surveys – we have a small number of very highly detailed studies of travel behaviour in a handful of cities. These are incredibly rich in detail about how people move around and why they make the choices they make
- Evidence of more-than-the-sum-of-the-parts impact for 'joined-up' delivery is best characterised by work we have on schools that shows that where we build a safe route AND support people to walk or cycle, uptake is greater (unpublished research – can be made available)
- There is also good evidence of the benefits of investing revenue alongside capital funding, most notably in https://www.gov.uk/government/publications/sustainable-travel-projects-revenue-and-capital-investment

- **How do these vary spatially? Are there distinctions between central, suburban and rural areas and are there differences between cities?**

18 We have extensive analyses that show the extent of difference in different settings. The contrast between, for example, data from travel behaviour surveys in rural areas (we have data from the

Yorkshire Dales and surrounding areas) with equivalent data for cities (e.g. Edinburgh and Glasgow) show all the degrees of difference that you might expect. We also hold examples in small towns (e.g. Kirkcaldy) where patterns also show key differences.

19 Programmes which include interventions of comparable nature in very different settings can also be very revealing. The best example we hold may be Connect2, where we have similar evaluations of 84 schemes which are in very diverse settings – urban and rural, high population density and low population density, serving different types of destinations, varied 'extents of environmental change', varied extents of community engagement, etc. See http://www.sustrans.org.uk/sites/default/files/images/files/publications/Sustrans_Transforming_Local_Travel.pdf, http://www.sustrans.org.uk/sites/default/files/images/files/Sustrans%20Fit%20for%20Life.pdf

- **How do they vary over time? Are there particular times in the week where demand has changed or seasonal variations which have emerged?**

20 Walking and cycling are subject to significant temporal variation. But this is to some extent a function of provision. We observe in cities that seasonal variation in cycling is much less pronounced than is the case on leisure routes in rural areas. We infer the blindingly obvious – that family leisure rides are more likely to be influenced by weather conditions than commuter cycling.

21 Sustrans maintains a database of cycle (and some pedestrian) count material. We have data from several thousand sites across the UK, some data sequences now going back for up to 15 years. This is an incredibly rich data resource. The data is typically an hourly, bi-directional flow. In most instances we know details about the location of the sites in terms of the nature of the route and the destinations served. Some unpublished analysis exists. This can be shared with the commission. Access to the database can be provided.

- **What methods can be used to incorporate greater uncertainty in demand? Have they been deployed and to what effect?**

22 The question of whether to suggest that demand forecasting needs to be more sophisticated, or whether it needs to be lighter touch, is a challenge in itself. Sustrans wants to see a situation where investment is driven by pragmatism. But pragmatism means different things in different settings, and the consequence of what might be seen as pragmatic over the past 20 years is exactly what has led to the predict-and-provide catastrophe that means that (beyond HS2) investment in roads is by far the most significant part of the transport investment profile for the current Government.

23 If more sophisticated demand forecasting would result in greater recognition of the role of walking and cycling, and correspondent investment in support of this, we would be happy to commend it.

24 However, we anticipate that in the current climate more sophisticated demand forecasting might in fact mean an over-emphasis on new technological solutions such as electric cars and autonomous vehicles. Electric cars have not seen uptake in demand at the rates of more optimistic

forecasts (although there is some alignment with some of the more pessimistic forecasts). And autonomous vehicles have so many challenges of implementation that it is impossible to see that they will offer significant change to transport provision within any sensible time frame – by which time we may well be in the throes of more significant disruption due to climate change.

25 Perhaps we have to conclude that factors in demand are so complex that we can't reasonably expect to be able to accommodate all variables, so demand modelling is necessarily flawed.

26 At a very practical level, one way to reflect uncertainties in demand is through transparency and sensitivity in modelling and forecasting. It would be more helpful if the assumptions made in demand modelling work were more transparent. This may not be favoured by modellers and scheme promoters, because it does mean that they would be likely to face more questions about why their assumptions are as they are. In terms of sensitivity, the range of possible outcomes is always helpful in almost any context. But again, the breadth in range that we might anticipate seeing in some instances may not flatter the modellers and promoters.

## Supplementary comments

- **Risk of reinforcing the predict-and-provide approach to transport planning**

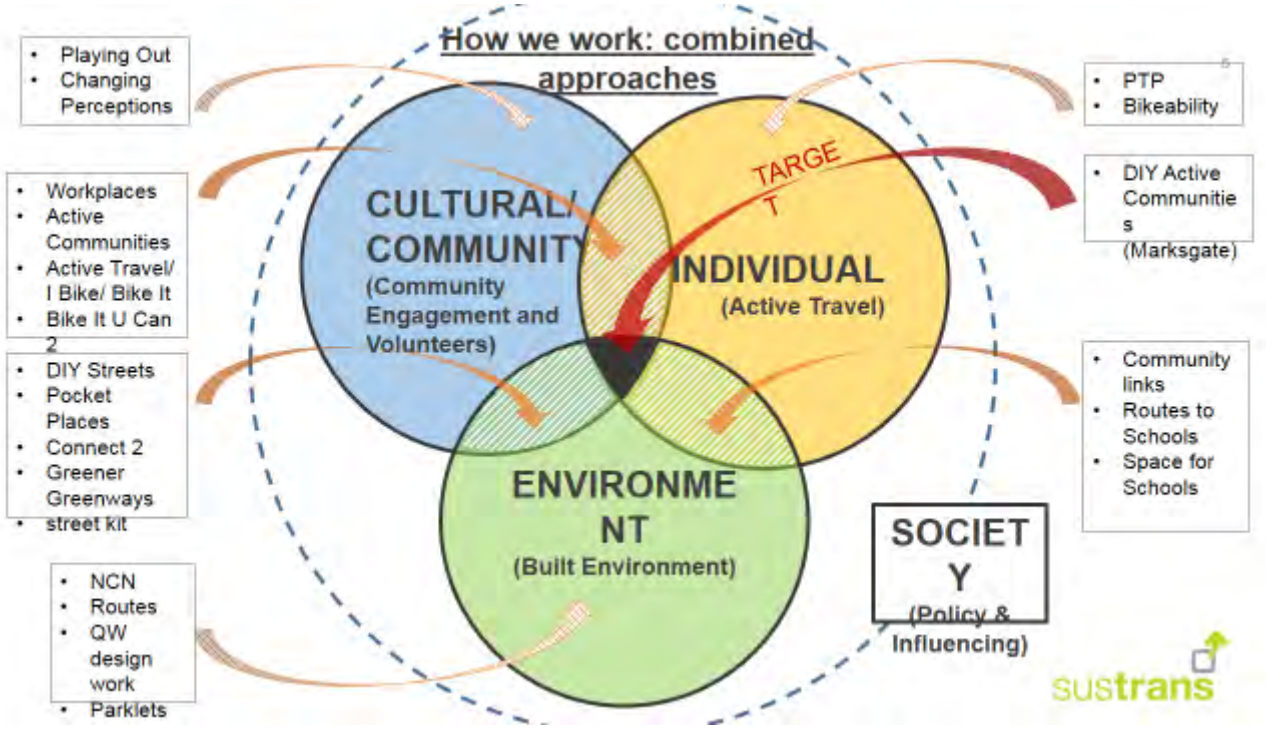
27 One of the major risks of the failure to understand demand is the way that current approaches act as a crutch for established practice to pervade. We are thinking particularly of the predict-and-provide paradigm. This says that we predict the future based on the past and cater for a future demand that fits within the constraint of the current. In this way, current approaches to provision of transport are 'locked-in'.

28 This problem is well-evidenced in terms of road building. We see historic growth in traffic; future models predict growth in traffic on this basis; we perceive that the way to deal with forecasted growth is to build new roads; traffic growth ensues. We disregard the possibility of changing the paradigm by changing provision.

29 A case-in-point for running against predict and provide is London. Twenty years ago conventional transport modelling would never have forecasted significant increases in cycling and decreases in motor traffic. But the congestion charge and investment in cycling have changed the paradigm.

- **Applying a socio-ecological model approach to Sustrans' work**

30 Earlier in this response I mention the application of a socio-ecological model to Sustrans' work. Just to elucidate, a diagrammatic version of the model is set out below. The relevance of this to submission is bound up in our response to the second question. We are trying to target the central intersection of the three circles with our 'joined-up delivery' approaches.




- **Sustrans' data resources**

31 Throughout this response I highlight numerous sources of data. I have not gone into the wider literature at all, or described the data that other organisations gather. All of the material cited in here can be made available to the Commission.

## Contact details

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# Commission on Travel Demand : An Initial Submission

**Tom Hart February 2017**

**1 THE COMMISSION** Establishing the Commission is timely in relation to new thinking on how to impact more rapidly on UK End Use Energy Demand as part of steps to accelerate cuts in greenhouse gas emissions from the transport sector but clarity is needed on whether the Commission will consider freight as well as passenger movement and opportunities for improved access with potentially less movement. Should reference should be made to additional work relating to demand for international movement? Should the title be modified to **The Commission on Future Movement and Access** and a reference added to the need for further work and international agreement on the future scale and nature of international movement?

At present, international movement by air has a high rate of growth though international shipping may be affected by some shift to intra-regional trade and major cuts in longer distance shipping influenced by large cuts in oil and coal movement and an increasing emphasis on the recycling of materials in ways involving lower energy costs.

**2 RATIONALE FOR COMMISSION** There is a case for modifying the three main rationales to be:-

1 carbon and other international obligations which will increasingly require demand reduction (this would recognise, not only carbon issues, but also the difficult, yet important, issues of moving towards carefully phased reduction, or stabilisation, in the human population to allow improved well-being for humans and reducing pressures leading to major, but adverse, impacts on the conservation of habitat and wildlife)

2 retained as stated

3 Institutional inertia in changing governance, skills training and the overall fiscal, regulatory and international framework affecting personal and business decisions on spending (though beginning to change, transport modelling and evaluation has tended to have a bias towards previous trends and towards infrastructure investment rather than testing future scenarios. It has failed to appreciate actual shifts in levels of overall movement and modal share reflecting personal decisions despite a pricing/regulatory framework tending to favour car use)

**2 RECENT CHANGE and its ROBUSTNESS**

As outlined in the previous submission on *Phases in role of Transport in the Economy and Society : Past, Present and Future* there are clear indications that for at least 20 years the volume of passenger movement per head of population within Britain (and in other countries of similar size and levels of development) has been stabilising but with a shift in share towards public surface-based transport, especially if rail-based and in larger cities. Domestic

aviation growth has also slowed substantially while freight movement within Britain has fallen even with an economy still growing – though with rail increasing its share, especially for longer-distance internal movement.

Government policies have been slow to recognise these changes with great reluctance to apply stronger pricing and regulatory policies to the road sector. Record growth in rail passengers and income has already contributed to a large fall in annual payments to rail franchise operators and a major increase in payments to government by several franchise operators.

Rail investment has risen to ensure some network enhancements and reduce the backlog of major track and signalling renewals yet there has been inertia in moving towards better control of costs, identifying top priorities and moving towards the levels of skills and technical innovation required.

Several cities have seen impressive gains in combinations of rail, tram and bus improvements but distinct regulatory frameworks for rail, bus and taxi/DRT have inhibited fares/services co-ordination. Shifts to public transport, walking and cycling could have been higher than those actually delivered with an arguable case that cycling has received more attention that that given to encouraging shifts to public transport.

In Scotland, Lothian Buses (owned by Edinburgh and adjacent Local Authorities) has had particular success in raising bus usage despite the introduction of a curtailed tram route in 2014 with integrated bus/tram ticketing. The introduction of trams, and planned extensions, is designed to cope with significant growth in the city population, including increased emphasis on employment in west Edinburgh and towards the south east in the coming decades. Parking charges have aided shifts to bus use.

Despite indications of change, land use strategies (in practice if not in theory) often retain an assumption that rising car use (and parking) has to be facilitated by appropriate land use policies for cities and regions despite actual demand for car use likely to be lower due to greater shifts to transport alternatives and to working, shopping and being entertained at home rather than requiring movement.

The Scottish Government is revising Transport and Land Use Strategy in the light of sustainable and fundable objectives. Present objectives already include inter-city rail trip times within Scotland shorter than by car. Yet actual funding continues to prioritise major funding for full dualling of the Inverness to Perth and to Aberdeen A9 an A96 routes by 2025 with much more modest investment in the parallel rail corridors

**ROBUSTNESS ISSUES** The current official view is that rail growth will now stabilise with the economy gaining more from acceleration of some major road schemes helping to accommodate population growth in areas designed for easy use of non-oil cars – possibly including electronic road pricing and significant shifts to automated cars in cities and on adapted motorways by the 2030s.

This view seems out of line with actual personal and business preferences (and health pressures) to move to much higher levels of car rental associated with greater use of high-frequency public transport and active travel in cities and also stronger preferences for rail use over longer distances. Such a shift could ease present parking problems and cut longer-distance road use (including shifts from HGVs to rail). It could also lead to some shorter-distance bus and taxi trips being made by automated cars but with roadspace and amenity considerations still encouraging higher, rather than lower, levels of high-frequency public transport use in cities and some other areas with large elements of tourist and leisure travel. Automation may apply more easily to mainly segregated rail routes than to road use

However, the case for extensive and expensive sections of ultra-high speed rail route (suited to 200-225 mph operation) may be weakened due to better overall value coming from enhancements in city region and existing inter-regional networks with good interchange at city centre hubs. Ultra high-speed rail has the drawback of the length of time and distance needed to reach top speed with top speeds never reached if stations are less than 100 miles apart. Better value may come from upgrades of existing inter-city route and some sections of new construction to 140/150 mph maximum speeds. Existing plans already envisage such services sharing with possible HS2 ultra high speed trains on route north from the West Midlands (as already happens on the HS1 line through Kent).

## The Problem of Peak Electricity Demand

Since many rail services are more heavily used at commuting peaks, this has meant (despite measures to improve fuel efficiency), that more intensive rail electrification could increase rail demand for peak electricity whereas battery or hydrogen powered road vehicles could be refuelled from electrical sources outwith peaks.

The existing shift to hybrid trains able to run directly on electricity or use diesel could be seen as easing this problem but the immediate reason has been to deliver cuts in the provision of electrical wiring which has risen well above budgets. The downsides include higher build and operating costs for such bimode trains. On busy and easy to electrify routes, full electric operation even at peaks is likely to remain preferable. Electrified longer-distance routes also have a more even pattern of demand over most of the day (and with nightline freight). Regenerative braking and further easing of the intensity of commuting 'high peaks' could ease electricity supply issues and ensure a larger contribution to greenhouse gas reduction and to urban air quality than the alternative of slower progress in shifting road vehicles to non-petrol and non-diesel power sources.

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**Extracts from Scottish Transport Statistics No 35 - Transport Scotland Feb 2017**

## Road Use

Traffic volume in 2015 1.2% up on 2014 (GB 1.6%) – up 6% since 2005

Number of cars 2005 2.1m 2015 2.4m

| | | |
|---|---|---|
| Buses | 12thou | 11.9thou |
| Taxis/private hire | | 22.8thou |

Road freight broadly stable but with continuing shift to larger lorries – and much higher growth in light van movement

**ScotRail** passenger trips up 0.5% on 2014 to 93.2m (69.4m 2005) +35%
Note 2014 usage was boosted to record high by Glasgow Commonwealth Games while various disruptions affected ScotRail in 2015/16

**Air** Passengers up 6% in 2015 and now just above previous peak in 2007

**Cycling** Up to 8.1% of work trips in Edinburgh (4% in 2005) but with much slower advance in rest of Scotland

## Ferries

| | | 2005 | 2015 |
|---|---|---|---|
| In Scotland | Passenger Trips | 8.3m | 7.8m |
| | Vehicles | 2.5m | 2.7m |
| To and from Scotland | Passenger Trips | 2.2m | 1.8m (Mainly N Ireland) |
| | Vehicles | .435 | .398 |

## Road Details

**Total Vehicle Kilometres**

| | 2005 | 2015 | |
|---|---|---|---|
| Major Roads | 28,055m | 29,072 | +7% |
| Other roads | 14,663 | 15,501 | +5% |

**Car Vehicle Kilometres**

| | | | |
|---|---|---|---|
| Major Roads | 22,060 | 22,573 | +2.4% |
| Other roads | 11,418 | 12,096 | +6% |

**Average Daily Flows** (thousands)

| | 2006 | 2015 |
|---|---|---|
| A74(M) Lockerbie | 32,156 | 33,313 |
| A720 Dreghorn | 78,386 | 78,624 |
| A80 Cumbernauld | 64,599 | 71,740 |
| M8 Harthill | 51,567 | 53,566 |
| M73 Gartcosh | 39,480 | 43,588 |
| M90 Kelty | 26,511 | 31,787 |
| A77 Kilmarnock | 24,470 | 27,340 |
| A90 Stonehaven | 24,921 | 26,650 |
| A9 Blackford | 25,870 | 26,338 |
| A737 Lochside | 20,469 | 22,055 |
| A96 Forres | 11,276 | 10,651 |
| A9 Tomatin | 8,717 | 9,307 |
| A1 Grantshouse | 8,554 | 8,047 |

## Local Bus Trips

| | 2005 | 2015 |
|---|---|---|
| **All Scotland** | 465m | 409m |
| Of which concessions | 156 | 143 |

| | 2005 | 2015 |
|---|---|---|
| NE,Tay/Central | 68 | 61 |
| H&I | 14 | 14 |
| SE (inc Falkirk/Fife) | 162 | 165 |
| SPT & SW | 225 | 169 |

## RAIL - Extra Data

**ScotRail passenger kms 2005** 2,283m **2015** 2,874m +30%

| | **2004** | **2014** |
|---|---|---|
| Passenger trips beyond Scotland | 2.4m | 4.3m |
| Trips to Scotland | 2.6 | 4.3 |
| TOTAL | **5.0** | **8.6** |

Notes (1) Further strong growth reported in 2015 and 2016, including high growth on trips to and from NW and NE England but reduced rail travel to SE England (except London) and to SW & Wales

(2) Rail data excludes **Glasgow Subway** use (12.7m in 2015 and 13.2m in 2005**), Edinburgh trams** 5m in 2015 and other trips operated on **heritage trains** on Network Rail track and on other lines plus usage of **Cairngorm Mountain Railway**)

**Average distances travelled by rail passengers to Aberdeen, Edinburgh & Glasgow 2014-15**

| | **Aberdeen** | **Edinburgh** | **Glasgow** |
|---|---|---|---|
| **Under 20kms** | 14.8% | 16.3 % | 44.5% |
| **20 to 49kms** | 25.3% | 35.3% | 29.5% |
| **50 to 99kms** | 9.9% | 16.0% | 12.1 % |
| **100 & over kms** | 50.0% | 32.4% | 13.9% |

This shows the high share of shorter trips relating to Glasgow area and the much lower share of such trips related to Aberdeen with Edinburgh in an intermediate position

| **Rail trips starting or ending in** | **Aberdeen** | **Edinburgh** | **Glasgow** |
|---|---|---|---|
| 2005-06 | 2.2m | 15.4m | 23.6m |
| 2014-15 | 4.2 | 21.9 | 69.4 |

**16** Scottish stations had over 1m passengers to and from them in 2005 rising to **30** in 2015

Among the 88 stations opened or reopened since 1970, most had high further growth 2005-2015

**2** had less traffic in 2015 (Prestwick Airport and IBM Greenock) and **8** were little changed

**39** saw usage rise up to 99% - including Livingston North up from 622th to 1.15m

| | |
|---|---|
| Bathgate | 645th to 1.22m |
| Livingston South | 227 to 343 |
| Dyce | 335 to 664 |
| Anderston | 341 to 625 |
| Crookston | 100 to 175 |

**22** saw usage more than doubling between 2005 and 2015 including

| | | | | | |
|---|---|---|---|---|---|
| SECC | 633 to 1.7m | Edinburgh Park | 353 to 890 | Portlethen | 15 to 56 |
| Argyle St | 574 to 1.4m | Musselburgh | 193 to 478 | Muir of Ord | 25 to 67 |
| Bridgeton | 240 to 632 | Wallyford | 127 to 312 | Beauly | 28 to 59 |
| Paisley Canal | 176 to 368 | Uphall | 249 to 582 | Alness | 8 to 24 |
| Summerston | 68 to 152 | Drumgelloch | 173 to 404 | | |
| Baillieston | 50 to 126 | Howwood | 33 to 125 | | |

**16** were not yet open more than 10 years in 2015 with the highest usage in 2015-16 being Larkhall 420th Alloa 386 Armadale 215 Caldercruix 112 and Laurencekirk 105

Though not open for the full year, Tweedbank already had 301th users and Galashiels 214

**RAIL FREIGHT** Rail Freight (measured in tonne kilometres) has fallen sharply from a 2005 peak but with a collapse in coal movement partly offset by rise in containerised and other bulk freight

## AVIATION : Passengers (million)

| | 2005 | | 2015 | |
|---|---|---|---|---|
| | **Domestic** | **International** | **Domestic** | **International** |
| **Aberdeen** | 1.7 | 1.1 | 1.9 | 1.6 |
| **Edinburgh** | 6.1 | 2.3 | 5.2 | 7.1 |
| **Glasgow** | 4.5 | 4.3 | 4.0 | 4.7 |
| **Inverness** | .56 | nil | .59 | .06 |
| **Prestwick** | .6 | 1.8 | nil | .61 |
| TOTAL | 13.5 | 9.5 | 11.7 | 14.1 |
| **Combined** | **23.0** | | **25.8** | |

Note International passengers have overtaken domestic by a large margin but, within the UK, some loss to rail of air share to London and Manchester, has been partly compensated by growth in domestic air travel to airports elsewhere in southern England, especially Bristol

## Cross-modal Comparisons

| | | |
|---|---|---|
| **Average passenger trip length** | Rail | 20.6km |
| | Car | 10.3km |
| | Cycle | 4.7km |
| | Walk | 1km |

No data is provided for air travel or buses but average air trip length is rising well above 400km due to the rise in international and longer-haul travel. Average bus trip length is likely to be similar to, or slightly below, the averages for cars.

In 2014 67% of adults reported **walking** more in the previous week than in any previous survey though often for leisure/health purposes rather than travel to work. **Cycling** data excludes off-road cycling. **Cruising** to and from Scotland and **leisure boat use** in Scotland has shown a substantial rise since 2005

2015 survey found that 77% reported making trips on the previous day compared to 80% in previous surveys. 14.1% of those in work reported working mainly from home compared to 11% in 2005. The rise in rail travel has been highest in off-peak periods rather than travel to work at peak times

**Understanding changing travel demand in Greater Manchester**

## Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?

1. Greater Manchester is a polycentric conurbation in north-west England with a population of 2.7 million. It has the most extensive urban motorway network in the UK and car travel is the dominant form of transport, especially if measured by person-kilometres moved rather than by number of trips made. Rail-based transport is important for travel to Manchester City Centre but much less so for other trip attractors.

2. During the second half of the twentieth century until the 1990s, travel demand in Greater Manchester changed rapidly, with car travel growing, and other modes of transport declining. As seen in previous revolutions of transport technology, there was a very large growth in total person-kilometres travelled during that period, as long car trips displaced short bus and walk trips. A redistribution of population and economic activity took place from the inner urban area to peripheral locations close to the new motorway network.

### *There has been little growth in car travel with a decline in the inner urban area*

3. But from the 1990s, car travel – which accounts for most motor vehicle kilometres – has not increased in Greater Manchester as anticipated by previous forecasts.

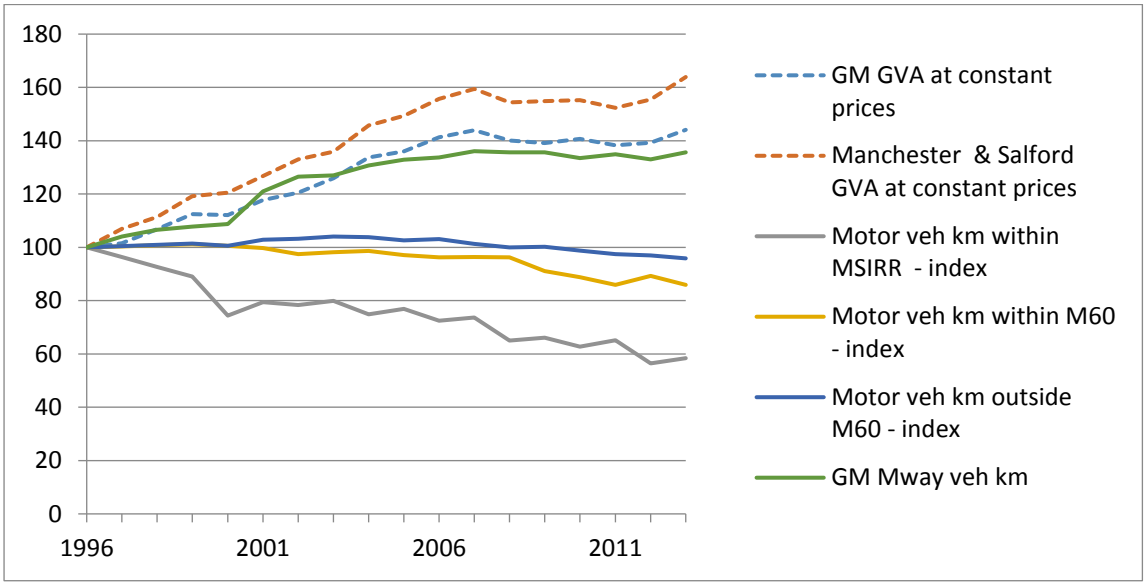
4. Figure 1 shows indexed values for motor-vehicle kilometres in Greater Manchester from 1996 to 2013. The blue, yellow, and grey lines respectively show motor-vehicle kilometres on the all-purpose road network outside the M60; within the M60 but outside the Manchester and Salford Inner Relief Route that surrounds the city centre; and within the city centre. All show declines in the period 1996 to 2013 with sharper declines in the inner urban area.

5. Note that economic and population growth has been higher within the M60 than outside the M60 – GVA within the M60 is approximated by the orange dotted line showing GVA for the Cities of Manchester and Salford. There has been a decoupling of road traffic growth from economic growth in the inner urban area.

6. The picture on the motorway network (presently accounting for about 45% of vehicle-kilometrage in GM) has been different, as seen in the green line in Figure 1. There was a strong increase following the completion of the last section of the orbital M60 from Denton to Middleton in 2000. The fall in motorway traffic after 2007 was affected by the economic slump from 2008, but traffic did not return to its

2007 peak until several years after the GM economy had surpassed its 2007 level of activity.

Figure 1: Changes in motor vehicle kilometres[1] by area of Greater Manchester – 1996 values set to 100




7. So, against expectations, overall volumes of car travel in Greater Manchester have been broadly stable over the past fifteen years, with some fluctuations. Particularly at odds with traditional forecasting approaches has been the decline in motor vehicle kilometres within the M60, coinciding with a growth in population and economic activity in those areas.

***While experiencing strong economic growth, the inner urban area has become more self-contained***

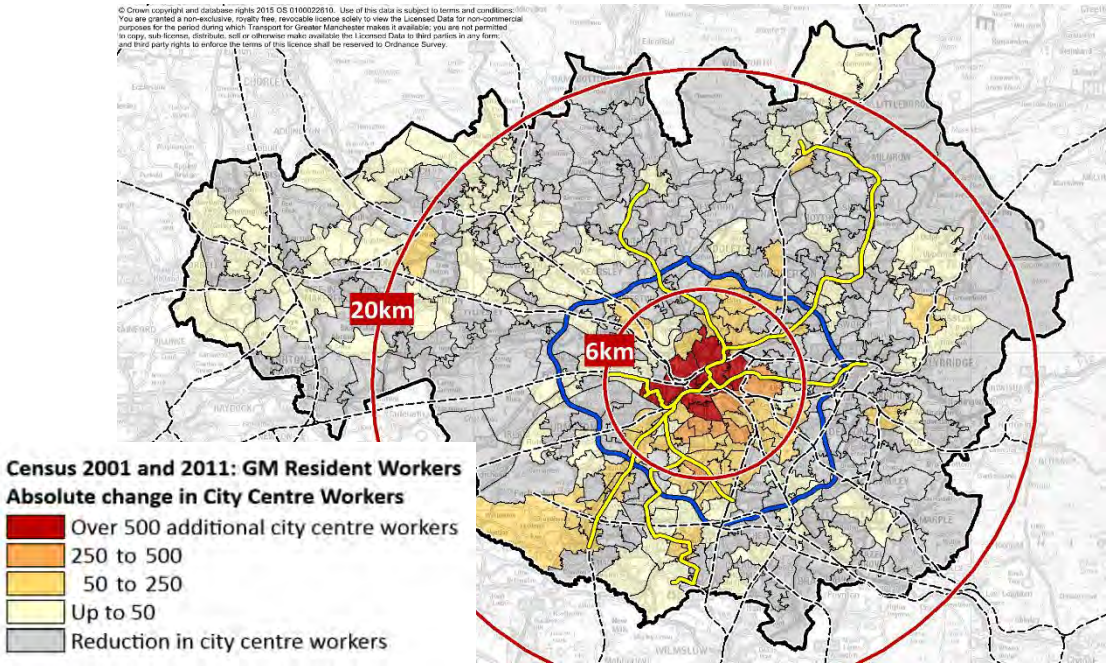
8. At the same time as it has experienced strong economic growth (for example, the number of jobs in Manchester City Centre increased by 17,500 to c.140,000 from 2001 to 2011) there is evidence that the inner urban area has become more self-contained. These phenomena would not traditionally have been expected to be found together.

9. Figure 2 shows that increases in numbers of city centre workers between 2001 and 2011 were concentrated in locations within 6km of the city centre. During the

[1] Values for the all-purpose road network are totals for links on which traffic counts were carried out throughout the period. Values for motorway are estimated vehicle kilometrage for all motors: a check has confirmed that comparing link-flow over time for motorways yields similar results (but creates complications due to the opening of new sections of motorway, specifically M60 Denton – Middleton, which is included in the 136% in Table 1). Note that "within M60" within M60 but outside MSIRR.

same period, there was a decline in the number of city centre workers with homes located between 6km and 20km of the city centre

Figure 2: Change in home locations of city centre workers, 2001 to 2011




10. Traditional suburbs such as Whitefield and Bramhall have become less important as homes for city centre commuters. However, more than 20km from the city centre, and extending beyond the Greater Manchester boundary, the picture changes again, with an increase in the number of city centre commuters being recorded from that distance band.

**How do these changes relate to the way in which the activities that we participate in have changed? What other factors may explain change?**

11. A contributor to some of the changes may be what can be loosely termed, "the digital economy". For example, internet shopping has replaced some shopping trips, perhaps especially longer shopping trips. But it is unclear to what extent the resulting fall in car kilometrage has been offset by an increase in "white van" kilometrage to deliver that shopping.

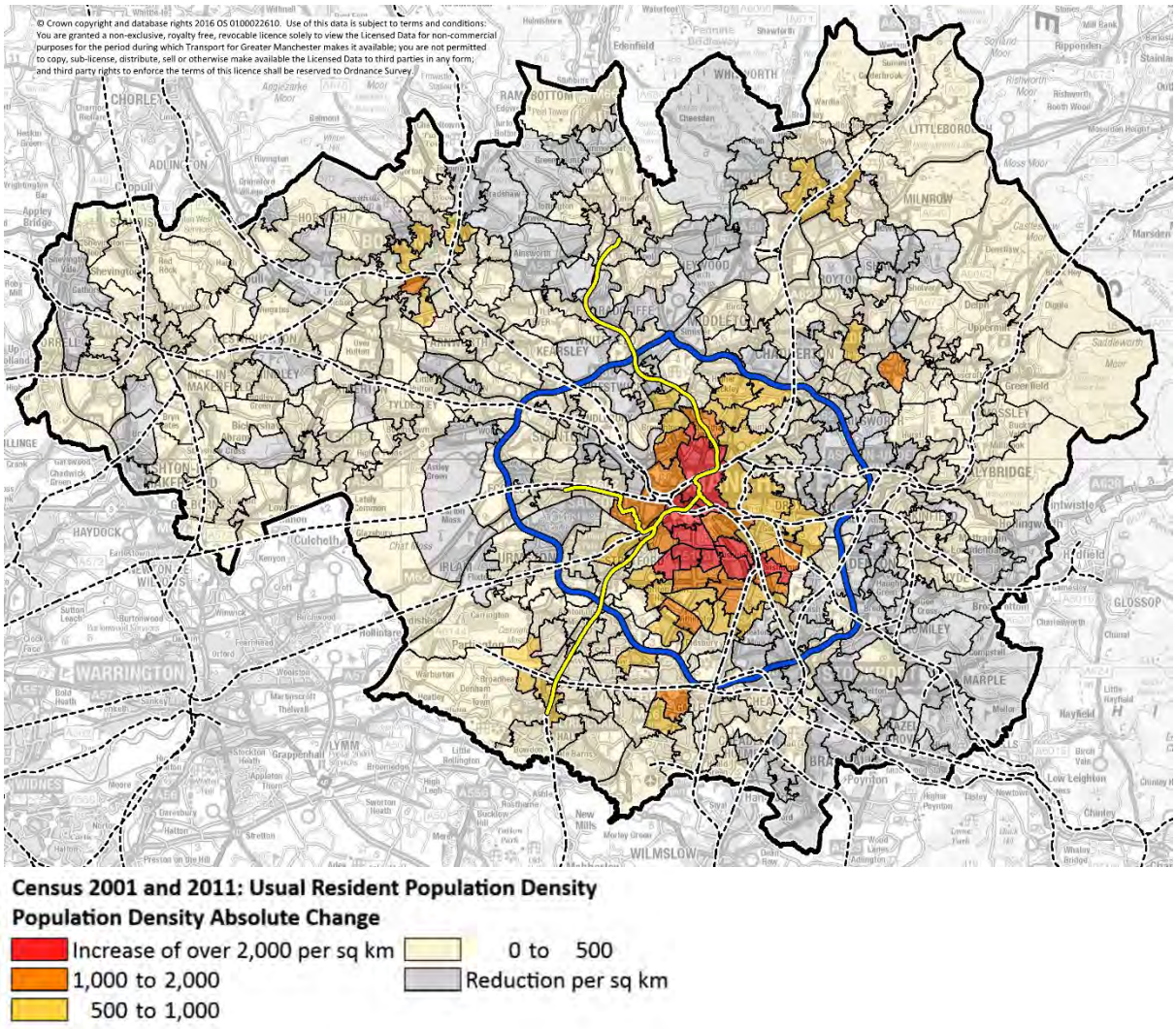
12. The digital economy does not seem to have led to much increase in the number of people working permanently from home: but by permitting home-working on perhaps two days per week, it may have led to a reduction in car kilometrage. However, it may also have facilitated more long-distance commuting, which workers find acceptable on a less frequent basis. That could help explain the changes in trip-length distribution of Manchester City Centre workers.

13. There is much more scope for using digital devices on public transport than when driving a car, and that is likely to have contributed to the plateauing of car travel. Rail-based public transport has increased strongly in Greater Manchester in the past twenty years, although much of that increase can be explained by improvements in service quality and extensions to the Metrolink network.

14. Cultural shifts may also help explain unexpected changes in travel demand. Throughout the developed world there has been a shift towards urban living, and that has affected travel demand. Indeed, changes in preferences on travel demand – e.g. the desire to be able to walk to a range of destinations – are an important driver of the shift towards urban living.

15. The shift towards urban living in Greater Manchester is clearly shown in Figure 3.

Figure 3: Change in population density in Greater Manchester, 2001 to 2011




16. Cultural preferences moving towards low-car lifestyles may explain the reduction in car travel within the M60, despite quite rapid population growth in that

area (which increased by 18% from 2001 to 2011 to reach a total of 800,000) and hence the overall plateauing of car travel in Greater Manchester. Digital communication probably also explains what would once have been regarded as paradoxical – how the inner urban area could become more self-contained transport-wise while enjoying particularly strong economic growth. An increased tendency for people to live near others with similar lifestyle preferences may be another factor.

17. But transport and land-use policy have also been important in explaining the changes. No new urban motorways have been opened in Greater Manchester since the completion of the M60 ring in 2000, although there has been a process of incremental increases to motorway junction capacity. On the all-purpose road network, there has been a shift towards improving the pedestrian environment, with deliberate reductions in either traffic speed or capacity, or both. Land-use policy has shifted towards the regeneration of the inner urban area. These factors have all been important in the plateauing of car traffic volumes and the revival of public transport, and also the growth of walking, for which data is more limited.

**What methods can be used to incorporate greater uncertainty in demand? Have they been deployed and to what effect?**

18. In view of the poor record of traditional transport demand forecasting models, scenario planning is a useful approach to considering the robustness of transport strategies to alternative futures. TfGM carried out some scenario planning with local authority partners to inform the transport strategy for Manchester City Centre within the GM Transport Strategy 2040. More scenario planning is planned as detail in the GM Transport Strategy 24040 is filled out.

19. More positive transport and land-use planning - “decide and provide” instead of “predict and provide” - is also an appropriate response to future uncertainty. One of the outcomes of the scenario planning for the GM Transport Strategy 2040 was that it highlighted that many of the key variables were to a substantial extent within the control of TfGM and the Greater Manchester local authorities. Many of the ”certainties” of traditional demand forecasting are in fact assumptions that past policies on transport and land-use will remain unchanged. Under a “decide and provide” or “vision and validate” approach, transport and land-use policy becomes a tool to support the vision for the urban area rather than a source of error in forecasting models, so that scenario planning can focus on genuinely external factors that lie outside the influence of local decision-makers.

**West Yorkshire Combined Authority (WYCA) submission to the Commission on Travel Demand – understanding changing travel demand**

**Introduction**

WYCA is keen to submit to this enquiry and to work closely with ITS in actively contributing, along with our partner districts. The submission below is hopefully a useful start, but we are keen to follow up in more detail in due course so it would be useful to see this as the start of a dialogue.

1. **Which aspects of travel demand have changed in ways which have not been anticipated by traditional forecasting approaches in the past twenty years?**

A number of demand forecasting studies have been undertaken locally for a range of different purposes over the years, while clearly we are aware of national forecasts from sources such as NTEM/ TEMPRO. We have in house economic and transport forecasting models, while each of the districts also have their own transport models. We also work with the likes of Edge Analytics to forecast future demographic trends. We are happy to fully share any of these with the enquiry as is useful.

There is also a range of local monitoring across modes undertaken by ourselves, our district partners and others including traffic monitors, publicly available info on station footfall trends, we can also get passenger counts (usually for automated counters on trains) via Rail North, and sometimes we get access to other industry tools for use in specific studies. We also have various surveys and similar carried out for various purposes from time to time.

While each of the demand forecasts are undertaken for different purposes and at different times, they clearly use different methods and assumptions to produce their figures so there is inevitably little consistency, and results do not necessarily reconcile. A current piece of work to be aware of is a demand and capacity study being undertaken for LCR (and DfT/ Rail North) by GHD consultants.

A number of our teams and stakeholders feel that the findings from the multitude of forecasting that takes place end up being "wrong" and this is an area that we can follow up in more detail with you. For example, it is felt that studies both here and across the country consistently under forecast growth in regional rail, in common with the major city regions of the North.

It's felt that a number of different studies have been done around the country into this, but they've not managed satisfactorily to 'close the demand gap', i.e. fully explain and predict the growth that we keep on seeing. From an LCR point of view, the current GHD study mentioned above is of most interest – although notably at present that too is coming up with relatively low demand forecasts.

This is an area that we are keen to work with the enquiry in more detail on.

2. **How do these changes relate to the way in which the activities that we participate in have changed? What other factors might explain change?**

A number of factors – national and local – are clearly affecting changing travel demands. Local trends to highlight include:

- Significant population growth forecast of up to 15% by 2028
- A trend of increasingly dispersed commuting trips with longer distances being travelled. Travel to work distance has increased over time as a result of more people working outside their district of residence. Between 2001 and 2011, average travel distances rose by 14.4% for West Yorkshire residents (from 11.3 to 12.9 kilometres). Leeds is increasingly being travelled into from other parts of the region – and forecast for this to happen further.
- Falling bus usage with uncompetitive journey times and major challenges with serving dispersed trip patterns
- Rail patronage in West Yorkshire has increased significantly over the last ten years, rising from 17.8m passenger journeys to 34.9m passenger journeys between 2004/05 and 2014/15 (a 96% increase).
- Distribution of new employment is predominantly in Leeds City Centre and east of the city, though uncertainty over final geographic spread
- Although City Centre jobs are increasing, car commuting is falling with City Centre living a key component
    - City centre jobs up 4%
    - Car commuting down 9%
    - Public transport marginally up – including rail
    - Cycling up 108%
    - Walking up 125%
- Half of new commuting to City centre forecast from outside ORR
- Traffic levels and journey times are forecast to increase

3. **How do these vary spatially? Are there distinctions between central, suburban and rural areas and are there differences between cities?**

There is no distinct spatial differences, other than the increasing role of Leeds in comparison to other local cities and towns. This is an area which we could explore more going forward

4. **How do they vary over time? Are there particular times in the week where demand has changed or seasonal variations which have emerged?**

Again, this is an area which we could potentially explore in more detail with the enquiry

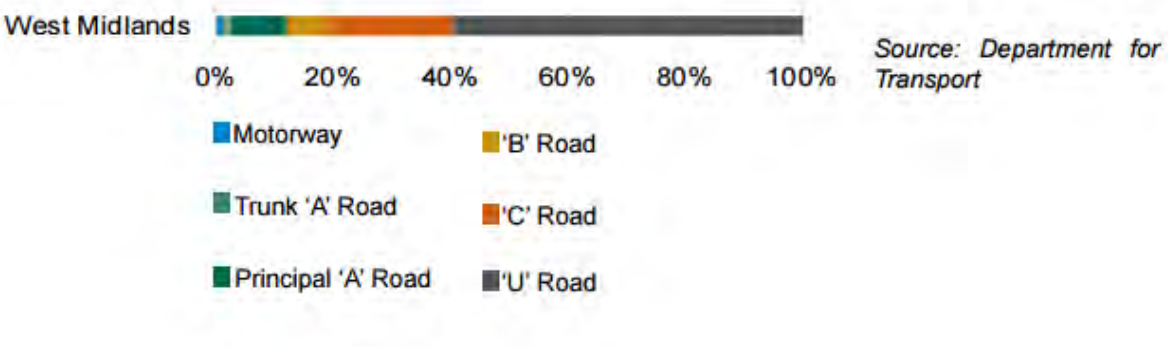
5. **What methods can be used to incorporate greater uncertainty in demand? Have they been deployed and to what effect?**

We are very aware of uncertainty in all of our economic, demographic and transport demand forecasting, and particularly that this uncertainty is likely to be greater in future. As well as reconciling and sensitivity testing our various forecasts, we are beginning to consider how to account for future uncertainty and would be interested to explore this with the Commission.

## 1. Background to the West Midlands

### 1.1 West Midlands and Future Transport

The West Midlands is at the heart of the UK's motorway network with the M6, M5, M40, M42 converging on and passing through the metropolitan area performing a crucial local and national economic function. Consideration of travel flows show that there is a complex mix of national, conurbation-wide and local journeys, covering a multitude of origins and destinations. There is a variety of road types covering urban, inter-urban, rural areas, providing a perfect encapsulation of all the potential environments within one co-located region.




Devolution and the creation of the West Midlands Combined Authority (WMCA) provide the West Midlands with an opportunity for transformation, with new powers and resources the area has an ambitious vision for the region in 2030.

Already home to hundreds of globally competitive businesses, provides a strong foundation for growth, along with a wealth of universities, science parks and research institutes, and supported by high quality rail, road and air links which will be strengthened by development of Birmingham Airport and the arrival of HS2. All which will contribute to an unanticipated change in the demand for travel which will inevitably create urban transportation challenges requiring innovative solutions.

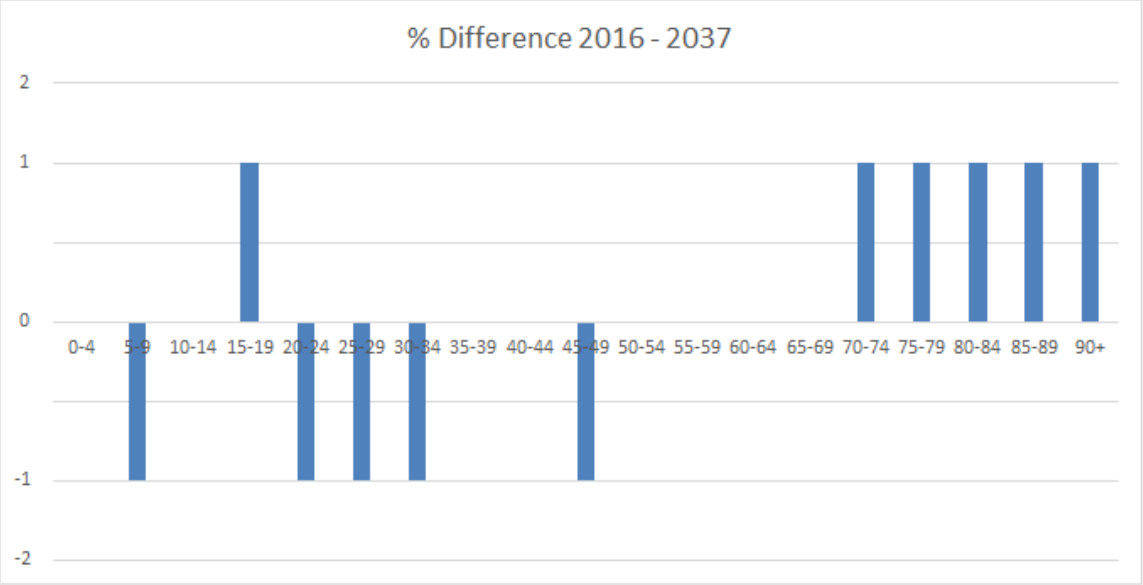
We need to meet the capacity and congestion challenges that greater demand for movement brings, at the same time we are seeking to reduce the environmental impacts from transport. The West Midlands recognises the major change this will bring and is gearing itself up to be at the forefront of innovative solutions. Operating as a UK hub the region is set to benefit economically and gain early results by introducing these technologies built upon the research and development taking place across the West Midlands.

Autonomous and connected vehicles are likely to have a significant role in a future transport system and bring transformational change into the urban environment, the major gains to be made in these areas are primarily via the reduction of vehicles in tandem with a move to full automation across all vehicles and the introduction of low or zero emission vehicles, increasing efficiency, safety and comfort, and providing mobility solutions to the public, both young and old. Autonomous vehicles promote low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility.

Connectivity has enabled a number of service providers to offer journeys comprising integrated train, bus and vehicle transportation and this is set to develop further in major cities, and in the freight operating sector. This will allow for a more efficient arrangement of transportation that improves road capacity and reduces the cost of transportation overall. Connectivity will allow for reduced congestion which will save time, increasing productivity and labour market flexibility. Connectivity will allow vehicle occupants to better use their time whilst in the vehicle.

## 1.2 Population

The West Midlands is facing population pressure both from rapid growth and also growth at both ends of the age spectrum. There is a large increase in the elderly population (as highlighted in the graph below), we also have an increase at the younger end too (15-19 year olds):




The youth and elderly populations have different needs but can be serviced by similar solutions in particular related to user-centric demand driven transport.

In the elderly group there is an increase in older drivers and a corresponding increase in disabled badges reflecting the desire for independence but also highlighting the impaired personal mobility that requires door to door services.

The younger group is an area where we are seeing a decline in the desire for car ownership and a reduction in the number of people holding driving licenses. The current thinking is that this group still have very personal transportation needs based on a door to door individual service but utilising a mixture of modes.

Autonomous vehicles will provide accessibility and empower those who are visually impaired and less mobile, offering a new lease of life, especially for those who either live in car-dependent areas or where there is limited public transport available. The diversity of the population in the West Midlands provides a perfect test bed to cater for different demographics.

## 2. Call for Evidence.

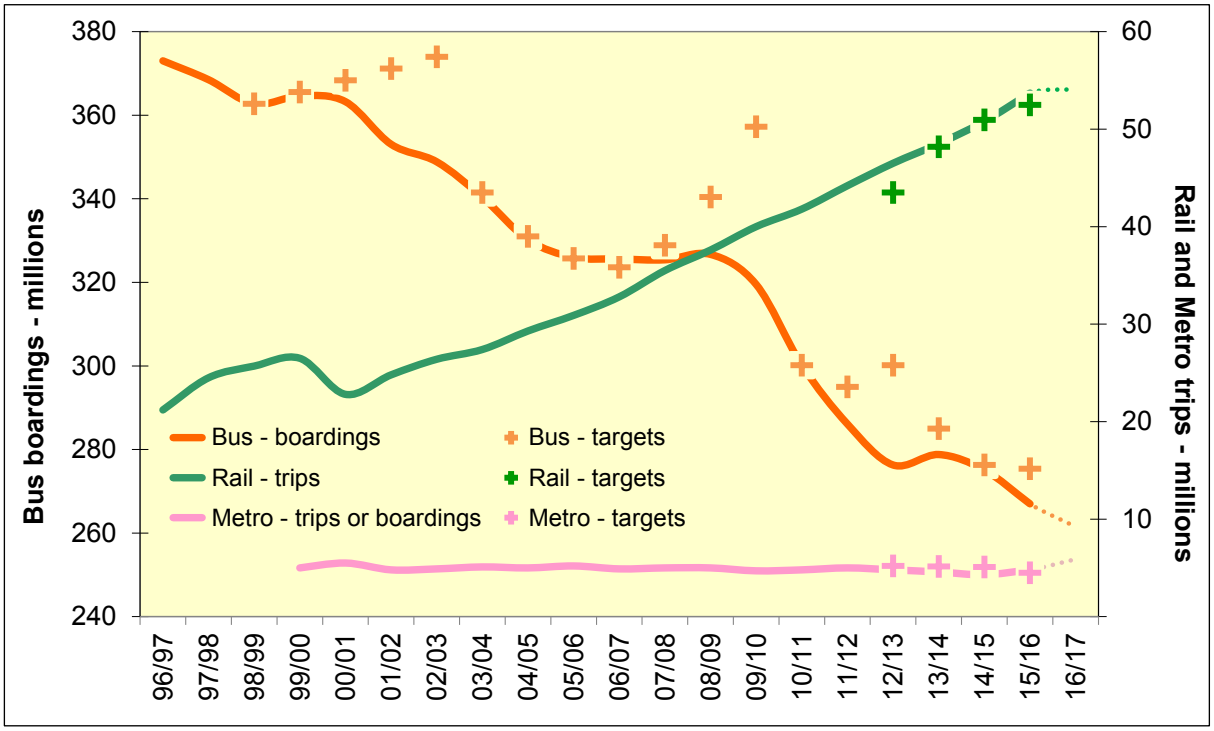
### 2.1 Changes not anticipated in last twenty years

The TfWM area has seen significant changes in personal travel demand in the last twenty years, and significant linked changes in the supply and use of transport services and networks by individuals and businesses – but these have not always been expected, or anticipated.

Looking for instance at the demand for public transport locally, TfWM and predecessor bodies were and are important actors in the public transport service delivery chain; promoting, developing, funding, and facilitating (although not operating), buses, trains and trams.

A lot of knowledge, experience, and skill is invested in these processes – and the forecasts, with appropriate sensitivity tests that are often part of them. But collectively, TfWM, private sector operators, highway authorities, and other stakeholders, have not always forecast public transport demand precisely.

Neither have outcomes always followed local targets as the chart below shows.




But the generally negative gaps between targets and outcomes for bus travel (the same has been seen with local cycling and walking targets), often reflect a desire to challenge trends, and create ambition, rather than a failure of forecasting.

But the positive gaps between targets and outcomes for rail (and Metro) do mirror gaps between forecasts and outcomes, with local Network Rail forecasts frequently lower than actual demand, although the gap has reduced over the period.

Neither have the usual uni-modal or multi-modal network modelling approaches been able to forecast the arrival of new telecoms technologies, with effects both ways on trip rates, and miles travelled, and impacts on destination choice.

Linked developments in transport supply, such as the increase in 'taxi' trips of all kinds (but especially private hire and remote hail models like Uber) from about 1% to 2% of all trips in the last twenty years (National Travel Survey West Midlands edit), or the increasing number and variety of car-sharing/hire models appearing locally.

## 2.2. Links to changes in personal activity – or other changes

Growth in rail use faster than established models often forecast will have had a number of causes, including those well-represented in conventional models; a larger population, rising values of time, regulated fares (not the case for buses), and traffic congestion and increased central area parking charges coupled with TfWM free Park and Ride spaces doubling over 20 years to more than 8,000. Lengthening commutes have seen the number of discrete travel to work areas identified in the Census for the region fell by 25% between 1991 and 2011.

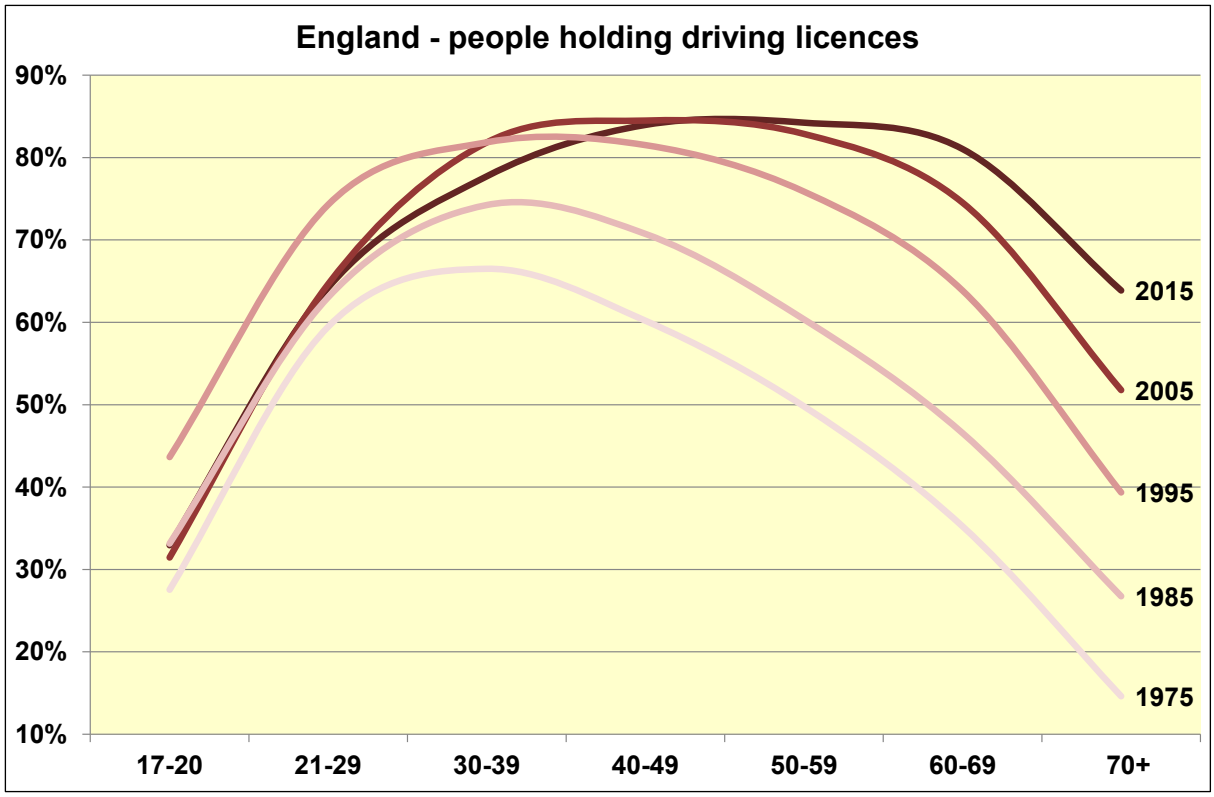
It is not clear how to separate the growth due to additional causes but the changing makeup of central area employment and working practices around flexitime and use of telecoms (easier on the train than in a car) are thought important in explaining faster rail growth than forecast.

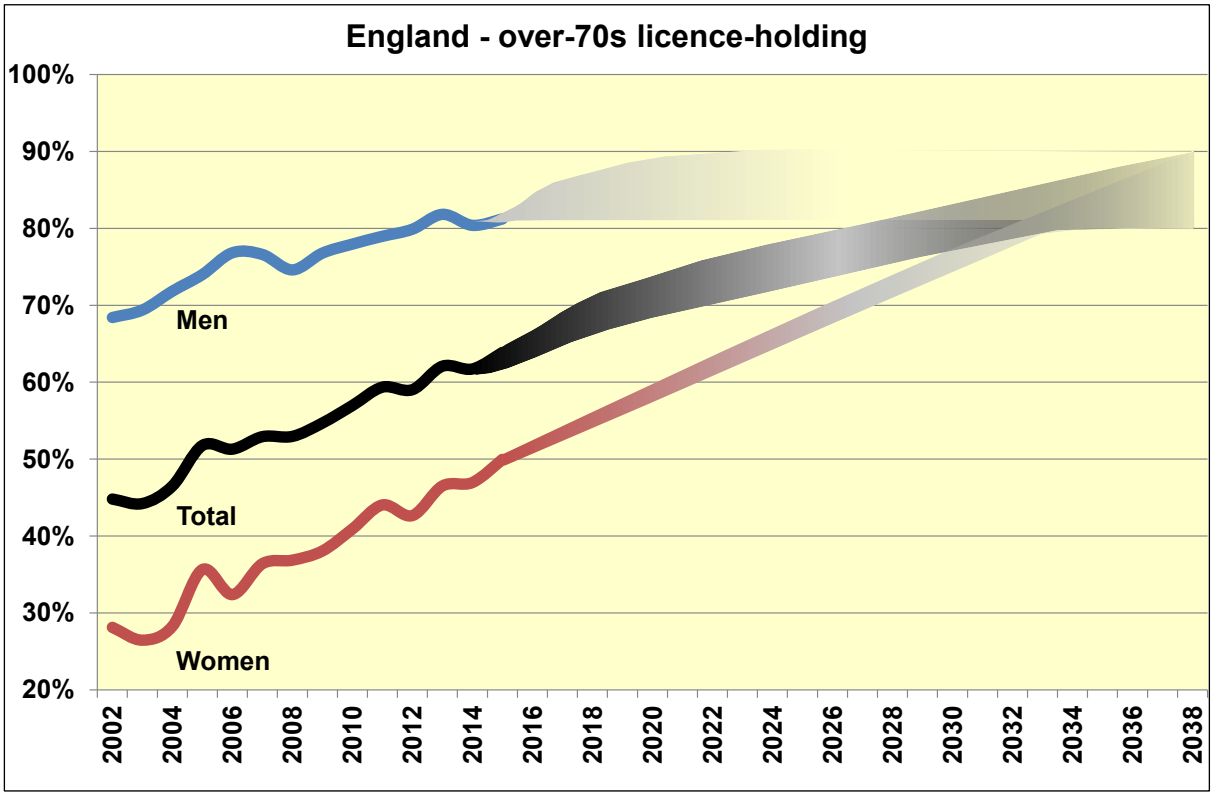
Likewise the impacts of new telecoms technologies on travel demand have partly been via changes in personal activity, with these encouraging interaction with a more spatially widespread but more selective set of employment, education, leisure, retail and other activities and relationships – generating trips further afield where affordable (suiting rail more than bus), even if these replace a number of shorter trips (walk trips are down one-third since 1996/7). And new telecoms also facilitate substation of trips, for cost and time reasons familiar to transport modelling (e.g. a video call instead of a visit, a home delivery or download rather than a trip to a shop).

As well as changes in personal activity, further changes, which are not so well-represented in established models, may help explain recent local travel trends.

One important change is in the distribution of income across different groups of the population, even as average incomes rise, which few models cover in detail. And the real-terms reduction in incomes of younger people locally (as wages and vacancies reduce), and real-terms rise in incomes for older people (at least those with pensions), are important causes of negative trends in bus use and in walking.

Younger people become less likely to travel so far (or at all), by bus, on foot, or by car (local average person trips by car have plateaued in recent years although traffic growth continues – population growth and goods vehicles). But as the charts below show, the rising older generation grew up with cars, and drive rather than walk or take the bus (local bus trips by older people have halved since 1990).


England - people holding driving licences
90%
80%
70%
60%
50%
40%
30%
20%
10%
17-20
21-29
30-39
40-49
50-59
60-69
70+
2015
2005
1995
1985
1975


England - over-70s licence-holding
100%
90%
80%
70%
60%
50%
40%
30%
20%
Men
Total
Women
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038

## 2.3 Spatial variation

These changes in opportunity also affect travel demand in less direct, but also important ways – for example, younger people are less able to form new households, and the overcrowding that can result within the home is mirrored outside where parking is at a premium, especially in the inner suburbs where incomes are under most pressure. Owning a car would be difficult for many local young people even if cost were not a problem – there is nowhere to keep it, and each extra car adds disproportionately to congestion whether on the move or parked. Taxi/Private Hire are more common choices now, and affordable where groups travel together.

But a lack of access to cars means bus services are still much more than a back-up service in many inner areas (often those areas originally planned by Districts around tram, and later, bus routes) and breaking down trend data shows that bus use is not falling so quickly in these areas – decline is happening in outer areas where more older people live, and around the smaller towns and cities, where walking and cycling are often the second place mode after car – but bus is the number two mode for work journeys in Birmingham.

## 2.4. Temporal variation

Change in travel demand by time of day, week, and year, includes the familiar phenomena of peak spreading, but also a growth in travel demand at weekends and holidays, visible in rising road and rail trips, and there are calls for improved rail services at these times. Meanwhile, bucking the trend of declining use, bus services over the Christmas period have been improved and are increasingly busy.

Travel by day of the week has also changed over the period, reflecting perhaps the changes in personal activity prompted by changing working practices – Mondays and especially Fridays are now noticeably less busy on rail services than midweek days.

## 2.5. Responding to uncertainty

Locally, causes of recent changes in travel demand beyond those at the centre of conventional models include new ways of working, and new technologies, and their impacts on personal activity patterns. They also include new variations on taxi (remote hailing) and car travel (car clubs and other sharing models), underpinned by new telecoms, and responding to changing levels and distribution of income.

A direct contribution to declining walk and bus trips, and increased rail and taxi travel trends is reinforced by indirect effects of these causes on household location and opportunity.

Incorporating these causes in forecasts, reflecting the uncertainty around their future direction, and leaving space for further unknown or unresolved developments, like the impact of Clean Air Zones (CAZ), or evolution of Connected and Autonomous Vehicles (CAV), is challenging – but TfWM takes the challenge seriously; using more detailed models better able to reflect changes in income by group, studying growth in

traffic congestion and ways to promote credible alternatives to single-occupancy car travel, working with younger people on their specific transport needs, and proactively contributing to efforts on CAZ and the development of CAV.

## 3. Customer Insight – Identify what people want from future travel

Current Customer Insight research is looking at the following areas to inform improved delivery and prioritisation of schemes/services and the further development of policy and strategy.

More information can be provided on the outcomes of the surveys if of interest.

**Customer Satisfaction Surveys:**

- Annual Customer Satisfaction with bus/Rail/Metro and Ring and Ride users: to monitor customer satisfaction with key modes of travel, benchmarking TfWM against other PTE's and local authorities.
- Annual customer satisfaction surveys amongst road users including car users, pedestrians and cyclists, to monitor satisfaction with issues such as safety, general maintenance and congestion.

**Users Profiles:**

- Regular user profile surveys amongst Bus/Rail/Metro users to better understand key public transport markets in terms of changing demographics, changes in travel patterns, changes in types of ticketing and information used and changes in attitudes towards modes.

**Smarter Travel:**

- Use/potential use of new ways of paying including Smartcards and contactless payments.
- Regular digital media survey to track use and changes in use of digital media amongst our key markets.

**Scheme monitoring and evaluation:**

- LSFT Monitoring, looking at success of sustainable travel interventions as part of LSTF programme looking specifically at the effect of Work Place Travel Planning, Education Travel Planning, Station Travel Plans and Personal Journey Planning in encouraging travel by more sustainable modes.
- Before and After surveys following investment on the network, evaluating the success of developments such as Park and Ride expansions, bus station developments, changes to services on the bus and Rail network and city centre re-developments.

**Passenger priorities survey:**

- Regular survey to look at changing passenger requirements, what passengers expect from public transport journeys and what could be done to increase usage.

# Commission for Travel Demand
# Submission from Transport for London
**March 2017**

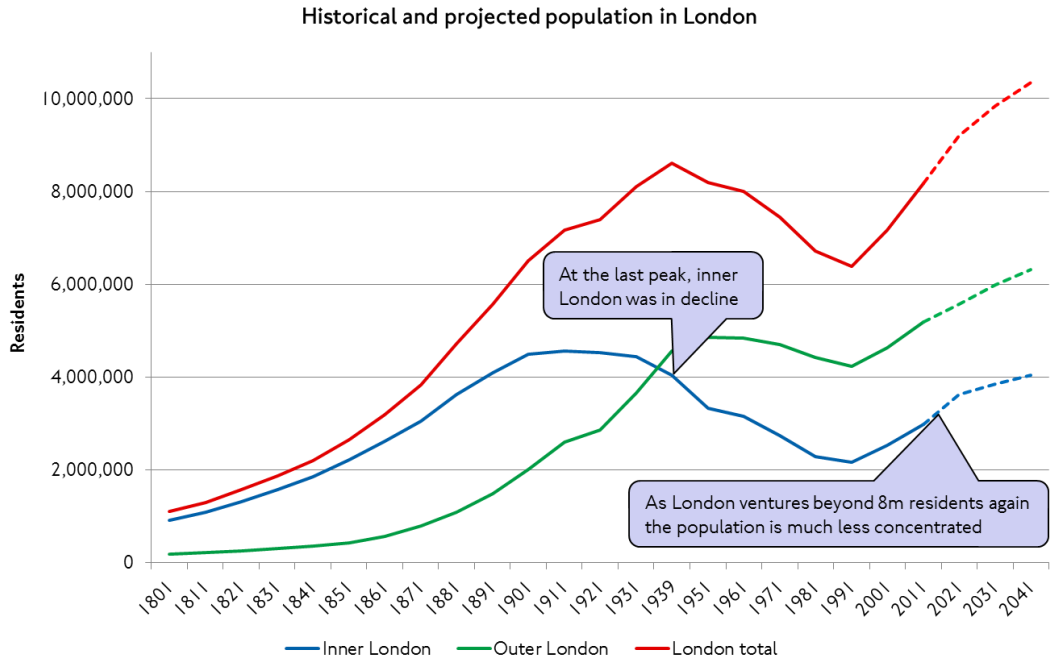
## Introduction

TfL is the strategic transport authority for London, governed by the Mayor of London and responsible for delivering the Mayor's Transport Strategy and managing those services across the capital for which the Mayor is responsible, including the London Underground, Overground, DLR and Tram networks, London Buses and the public transport network, the strategic highway network and for delivering active travel services.

## Changes in travel demand: the decline of the car

London has changed radically over the past two decades. Following a long period of population decline, population growth returned to London in the 1990s and the capital city is now the biggest it's ever been. At the last peak, in the 1930s, the populations of inner and outer London were broadly equivalent. Today, the shape of the capital is different with a more dispersed population. These suburban lifestyles were facilitated first by the expansion of local rail and Tube networks and later by the car. They were accompanied by a huge rise in car ownership and use, with both also strongly associated with rising incomes.

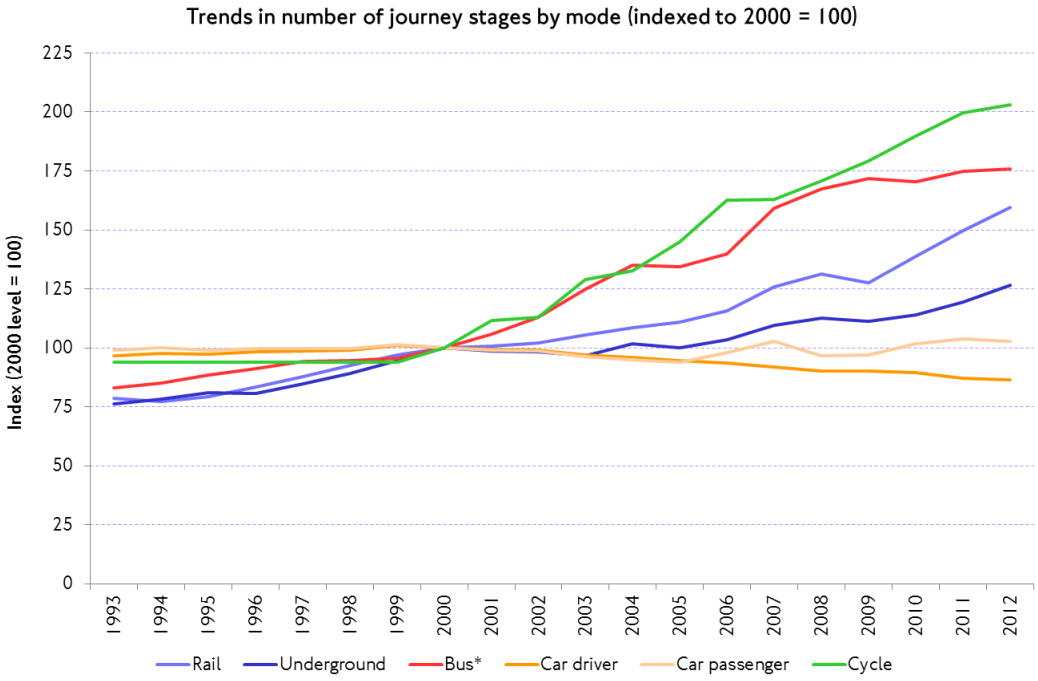
***Figure 1: Historical and forecast population in London, 1801 to 2041***




Trip rates in London have remained broadly stable for decades and so the total volume of travel has reflected the number of people living and working in the city. Notably, however, in the 1990s, population growth was not accompanied by equivalent growth in car travel, and from 2000

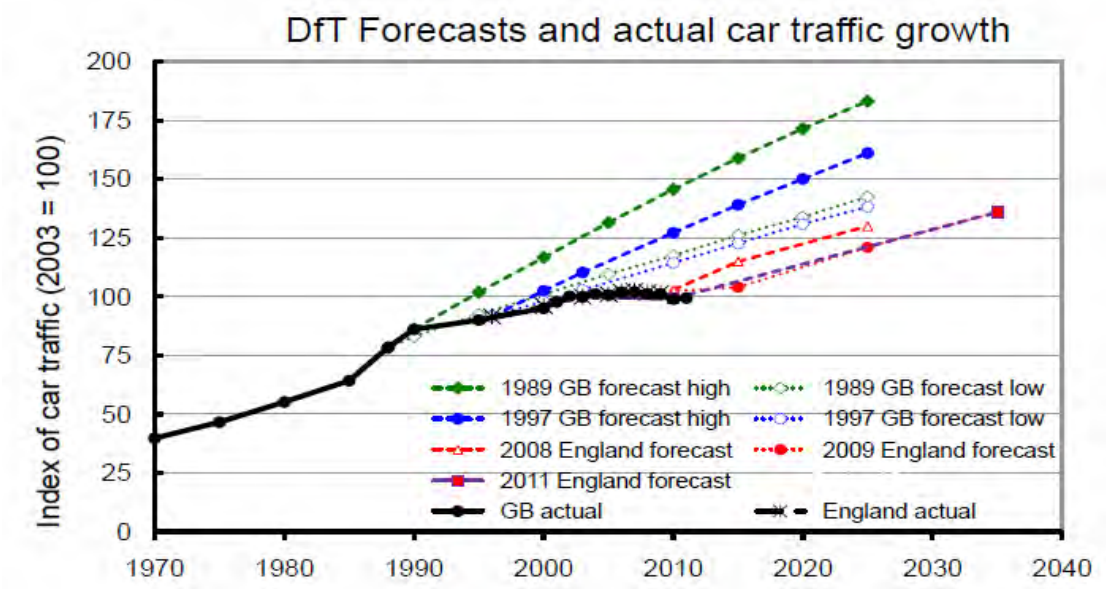
onwards demand for car travel began to fall. Since 2000, the car mode share has fallen by 11 percentage points from 48% to 37%, with fewer kilometres travelled by car. Compared to the rest of the UK, car ownership is less common even amongst the highest income households, especially in inner London.

***Figure 2: Trends in journey stages by mode 1993 to 2012***




By the 2010s, it had become clear that traditional demand models were not satisfactorily forecasting travel demand, with models continuing to predict rising car travel as shown in Figure 3. TfL launched a series of studies to better understand the characteristics and drivers of travel demand, and a programme of model development to enable transport models to better reflect real-world conditions and trends. Significant improvements have already been made to the existing demand model to improve the credibility of our forecasts, and the next generation demand model will launch in 2017. TfL continues to study the drivers of demand, with a particular focus on understanding how new and emerging technology might change the way we travel.

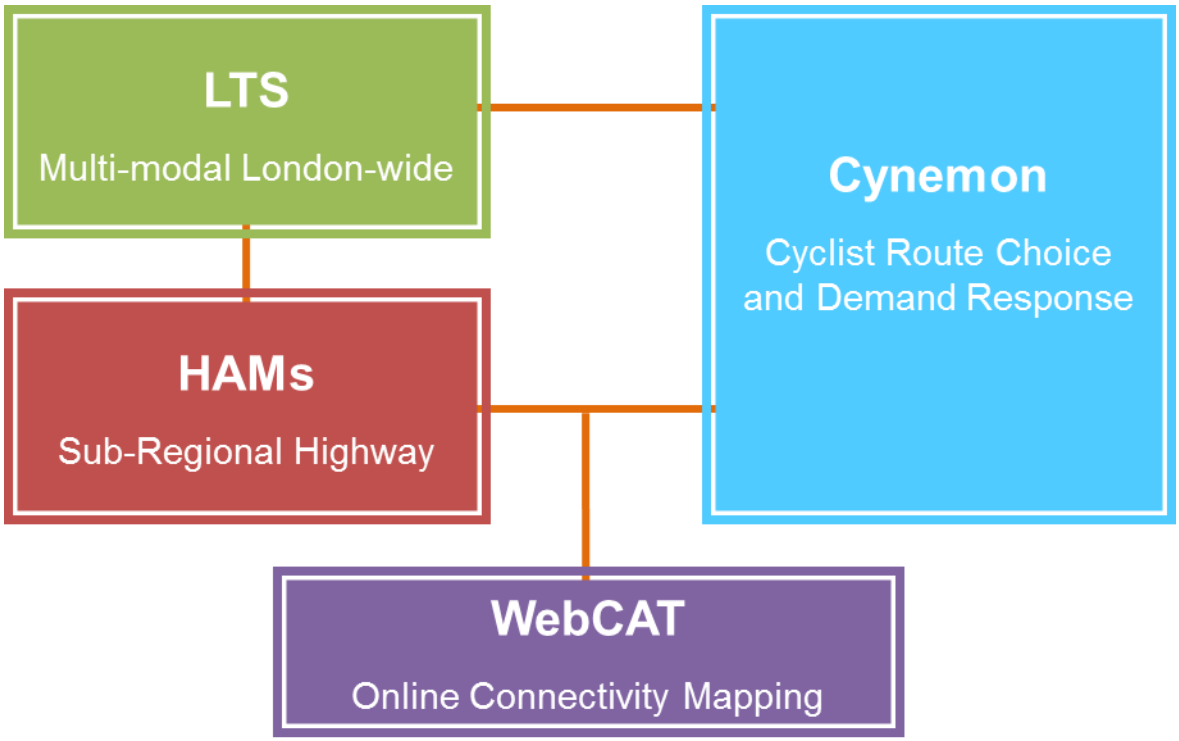
***Figure 3: Comparison of DfT forecasts and actual car traffic growth***




**Changes in travel demand: the rise of cycling**

Smaller in volume, but of great interest, is the rise in cycle travel that took place over the same period. Between 2000 and 2016, cycle travel in London grew by 118%. TfL's demand and assignment models were not well equipped to reflect the emergence of cycling as a popular option. An extensive programme of analysis, research and model development is now nearing completion, so that by 2018 cycling will be integrated in TfL's mainstream models, supported by bespoke tools supporting policy development.

***Figure 4: TfL's suite of modelling tools***




**Understanding the drivers of demand**

Travel demand is a complicated function of many factors including: population, demographics, economy, incomes, supply of public and private transport, public and private transport network 'quality', and costs of travel in terms of both money and time. TfL's 'Drivers of Demand' study identified three categories of factors determining travel demand:

1. **Supply factors**

   The supply changes that have influenced travel trends are perhaps the best understood. The investment that has been made in the public transport network, improving both capacity and quality, has led to an increase in demand on these modes. In contrast, capacity for general traffic on London's road network has declined over the long term, making car travel less appealing again relative to public transport in terms of journey time. In addition, changes to parking policy and regulation introduced in the mid-1990s have continued to have an effect on the total quantity of parking spaces available and restrictions on their use.

   There have also been increases in public transport fares during the period of interest. In isolation, these fare increases would be expected to cause a reduction in the quantity of travel by public transport, but with the cost of travel by car increasing similarly while the balance of capacity and service quality has shifted, public transport ridership has continued to increase.

2. **Underlying demand factors**

   Underlying demand factors such as London's economic output, as measured by GVA (Gross Value Added) and household incomes have also influenced travel. Income is an important factor, not only because people with higher incomes make more trips, but also because income influences individuals' choices about which modes of transport they use. The long term trend for increasing incomes was disrupted by the recession, and per capita incomes in London have fallen in real terms in recent years. The influence that income may have had on the observed trends appears stronger again when inner London and outer London residents' incomes are disaggregated.

   Inner London saw real incomes increase by 18 per cent from 2003 to their peak in 2009, while in outer London there has been no increase since 2003. With the majority of car travel taking place in outer London, this stagnation in incomes may have placed a cap on the amount of car travel, while inner London has benefitted to a greater extent from public transport improvements, and has seen car travel fall despite rising incomes.

3. **Structural changes**

   In addition to the supply and demand influences that have been in effect, it appears there have been some structural changes in the drivers of travel demand in recent years.
   Changes in attitudes toward car ownership and use, perhaps partly a result of improved public transport services and the increased cost of taking up motoring, mean that London's youngest residents are now much less likely to hold a driving licence than was the case amongst previous cohorts.

   Another area of significant change has been in the types and locations of employment that take place in London, with the distinction between blue and white collar workers that was

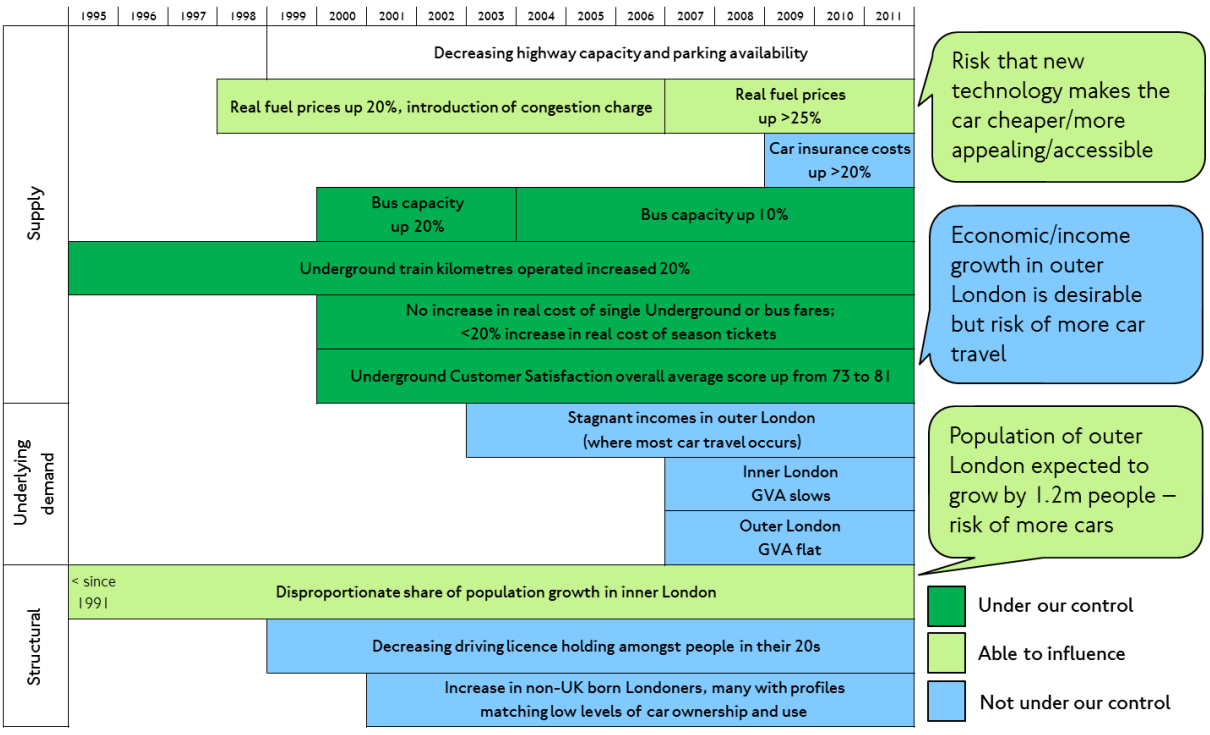
once linked to travel characteristics no longer appearing relevant. Working arrangements have also evolved, with a higher proportion of the population now working part-time – a characteristic often associated with higher rates of travel.

London has also seen continued in-migration, including from EU accession states, while the rate of out-migration has slowed, resulting in increasing numbers of families with children living in the capital. The proportion of Londoners born in EU states other than the UK and Ireland rose from 3 per cent in 2001 to 11 per cent in 2011. That many of these migrants are more likely not to own cars and to live in inner London explains part of the phenomenon of increasing population without increasing car use.

A further influence on London-wide travel also relates to the inner and outer London distinction. 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. With inner London residents making only half the number of car trips of their outer London counterparts – a pattern that is constant across the spectrum of income bands – the accelerating densification of inner London relative to outer London has also contributed to sustained mode shift toward walking, cycling and public transport.

Crucially, the study found that almost every area had seen significant changes that supported modal shift away from car travel to public transport, walking and cycling, with very few factors pushing in the opposite direction. A change or reversal in any of these factors could make continued mode shift more challenging in future. Figure 5 summarises the findings and challenge ahead.

***Figure 5: Drivers of demand***

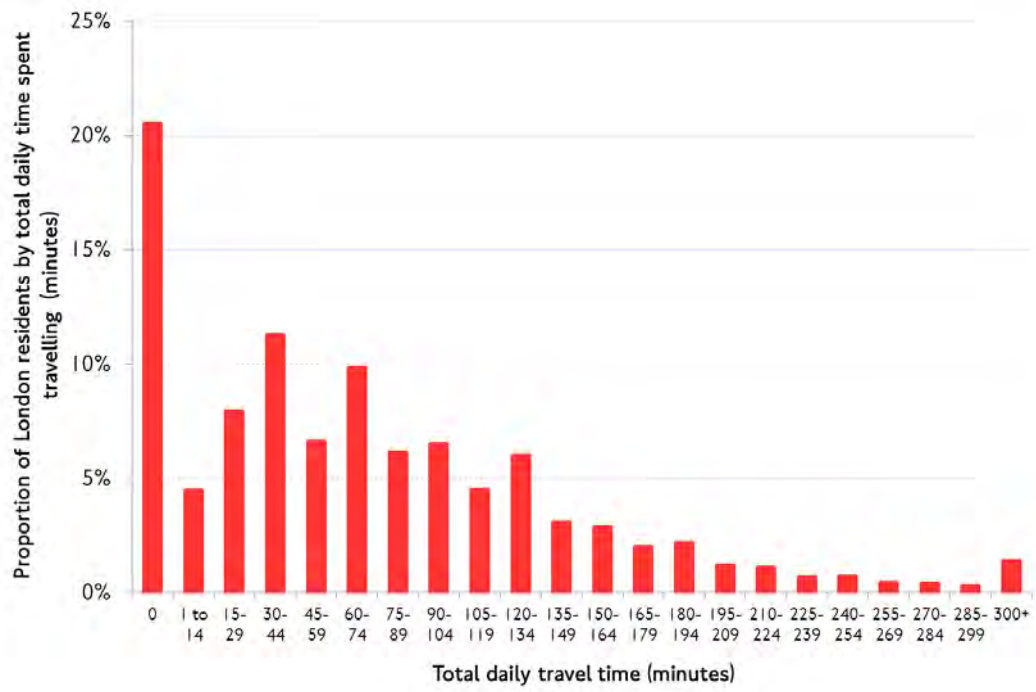



**Emerging trends: decline in the amount of travel**

Whilst travel demand per person has remained stable for a very long period, evidence is emerging that trip rates are starting to fall and that the amount of time people spend travelling is also falling. Within the transport industry, concepts of a 'travel time budget' or constant have been popular, suggesting that although forms of urban planning and transport may change, and although some live in villages and others in cities, people gradually adjust their lives to their conditions such that the average travel time stays approximately constant. However, TfL now considers that using a one hour travel time budget is not a useful touchstone for the planning of the nation's infrastructure needs in the long term.

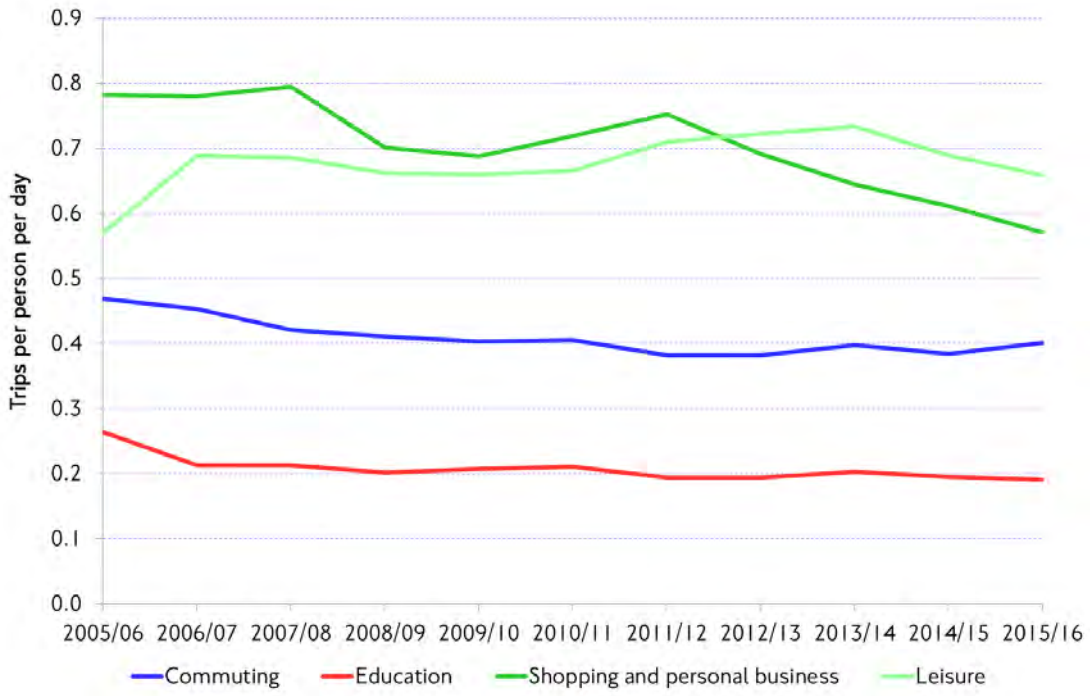
Between 2006/07 and 2015/16, the amount of time the average London resident spent travelling had fallen from 73 to 66 minutes per day, a drop of more than 10 per cent. In particular, there has been a rise in non-travel, in other words, people staying at home all day and not making any trips. On any given day, around 20% of Londoners do not make any journeys. At the other end of the scale, 22% of the London population spend more than two hours travelling per day. The average amount of time spent travelling per day differs for individuals with different characteristics, with full time workers, people aged between 25 and 59, and people living in households with incomes over £35,000 all travelling more than average.

***Figure 6: Total time spent travelling in minutes on an average day, London residents***




We do not currently have a good explanation for the reduction in time spent travelling, given continued economic growth, and a study is underway to better understand this. One clear trend however is of a decline in travel for shopping, as shown in the figure below. There appeared to be initial evidence that this was being replaced with travel for leisure purposes but the latest results have showed leisure travel returning to the previous level. London has seen significantly more van traffic in recent years, suggesting that at least part of this reduction in shopping travel is explained by increased online shopping.

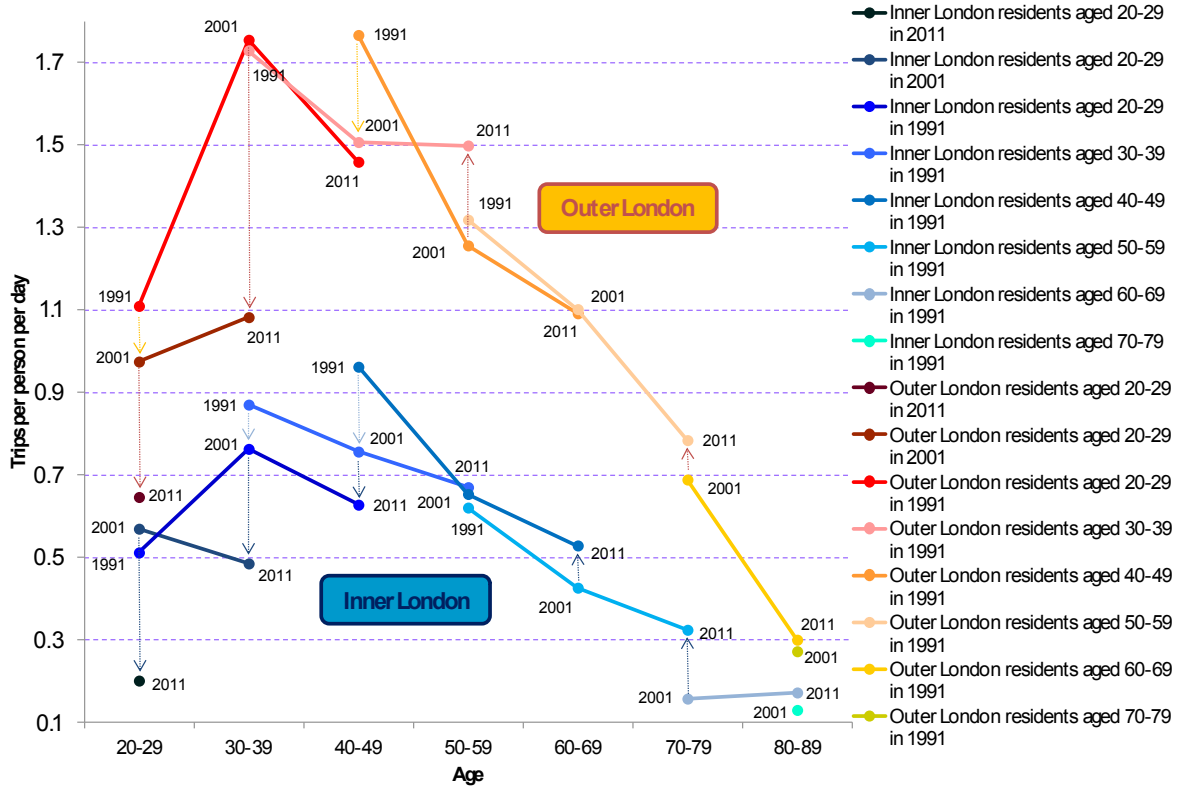
***Figure 7: Travel by journey purpose, London residents, 2005/06 – 2015/16***



**Emerging trends: cohort effects starting to emerge**

Analysis of three large-scale surveys of personal travel in London, spanning the period 1991-2011, shows both the way that travel patterns change over the life cycle, and clear evidence of a 'cohort effect' such that as each generation moves through their lives, their car use rises, but each generation is driving less than their predecessors. Young people in their late teens and 20s are less likely to hold a driving licence and be the main user of a car than their predecessors. Behaviour in relation to car ownership illustrates similar generational lag effects, with people currently in older age groups tending to maintain travel patterns established in their earlier working age years, while contemporary young people have by comparison a much reduced propensity to obtain the means to drive. What these (younger) people do next, and identifying the opportunities to influence their decisions, will be a major factor influencing travel demand patterns in London in future years.

***Figure 8: Car driver trip rates (average weekday) for London residents, by cross-scetional cohort and inner/outer London for the years 1991, 2001 and 2011***




**Emerging trends: the introduction of 'new modes' of travel**

The evolution of new technology has already spurred new approaches to transport services in London and this is only set to continue. There is a risk that new ways of accessing cars could reverse mode shift by making cars cheaper, more accessible and more appealing. For example, the decline in license holding amongst young people has contributed to the decline in car travel, but new technology that opened up car travel to more people, or removed the cost burden of ownership, could reverse that trend. Nevertheless, the same innovations, managed well, could deliver further mode shift from the private car – shared car services could feasibly reduce car ownership and thus the amount of induced car travel, whilst new demand responsive higher-occupancy services could expand the reach of the public transport network in lower density areas where it is more difficult to provide efficient conventional public transport services.

**Better reflecting uncertainty in demand modelling**

There are several areas of uncertainty in future travel demand:

- Growth forecasts including:
    - economic growth;
    - the relative success of London and its place in the world; and
    - population and employment location.
- Changes in behaviour/preferences such as the rise of cycling, the health agenda and declines in urban car ownership
- External technological change, including disruptive and transformational influences such as Uber and the *'Internet of Things'*

The economy, population and employment location have a direct impact on travel demand. The number of people and jobs in London drives total travel demand. There have been periods over the past 50 years of rapid decline and growth in population. The current projections assume strong growth but they assume a continuation of trends in London's success. The location of population and employment is important for mode share as people who live and work in inner London make far fewer car trips than those in the suburbs. The trends in population movement have varied significantly over past decades. Demographics are also important. Projections assume a rise in older adults in London and declines in birth rates over time. These have been predicted in the past but haven't come to pass.

Changes in aggregate travel behaviour do not necessarily reflect genuine changes in preferences. Transport forecasts are being developed for urban areas where the context is substantial travel demand change over the past 15 years. As Drivers of Demand has shown, some of the changes we have seen contrast with conventional relationships in transport planning which assume rising incomes mean more car use. If people travelled today as they did in 1991 there would be almost 2 million more car trips a day in London and over 2 million fewer public transport trips. However, most of this change is attributable to changing land use, population demographics and financial costs of travel and not fundamentally different travel behaviour. There has been a rise in some 'lifestyle choices' such as the growth of cycling to work which may reflect preference change. There is great uncertainty about long term trends in these elements.

Technology has the ability to radically change travel demand. Most mainstream travel forecasts used for appraisal do not consider a significant change in travel behaviour as a result of autonomous vehicles. There is great uncertainty about how this technology could develop and whether it would lead to more or less shared mobility and more or less everyday car use. There is also uncertainty about the speed of adoption with some experts predicting significant uptake by 2025. Technology could also influence overall travel demand – will past predictions about telecommuting and home working come to fruition with reduced commuting? Will technology negate the need to travel completely? These are impossible questions to answer but are important to consider when designing schemes in the long term.

**Improving the representation of uncertainty – Sensitivity testing**

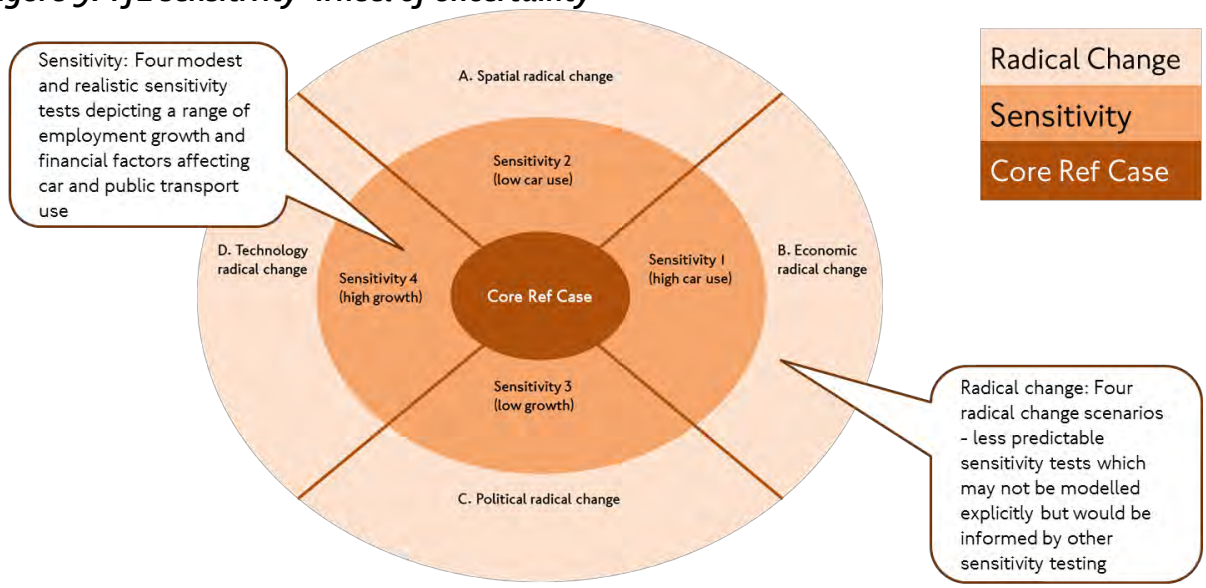
TfL has developed an approach which recognises the inherent uncertainty in forecasting. Robust assessment involves understanding how changes in the assumptions that form our future reference cases could influence schemes and policies as well as the core challenge. Our analysis

approach is to vary input assumptions in our modelling rather than changing the modelled relationships. This will identify if proposals have a better or worse case under alternative assumptions. For example:

- Does the necessity for Crossrail 2 depend on the highest projection of population and employment growth or is it required in all likely futures?
- What effect might sustained low fuel prices have on mode share and will this mean that a demand management proposal will not achieve the desired reduction in congestion?

TfL has developed a series of sensitivities to the core assumptions to reflect the inevitable uncertainty about the future and to understand how different possible futures might affect the nature of the transport challenges faced by London. These sensitivities are expressed as a series of modelled and hypothesised tests shown in Figure 9 and described as a 'wheel of uncertainty'.

***Figure 9: TfL sensitivity 'wheel of uncertainty'***




Note: Only changes to population or employment will affect total trip making by all modes

These sensitivities vary modelling inputs in order to stress test conclusions. The inner ring shows a series of modelled sensitivity tests. These modelled scenarios change input assumptions to reflect changes that could be considered reasonably likely, such as somewhat lower or higher population or economic growth than is forecast, or differences in the costs of travelling by car or public transport reflecting political changes to fares policy, fuel prices and so on. They provide a useful range of likely outcomes from which to assess schemes - the best schemes will hold their own in all of the 'inner ring' scenarios. The 'outer ring' represents changes that cannot reasonably be modelled, but which should be considered when thinking about the longer term. These include the changes to our way of life that technological developments could bring – some, such as automated vehicles, are already under development, others may be completely unforeseen at present. Major political or economic changes could have a similar impact – would forecasts in the 1970s have predicted the shift from a manufacturing to service economy, or in the 1980s have predicted the rise of inner London, or the success of Canary Wharf?

There is an expectation that where strategic modelling is required by a scheme/strategy, there will be an assessment against the most relevant sensitivities, with the results presented within the

economic case for the scheme/strategy alongside the core modelling and supported by a discussion of the potential impacts of more radical changes as represented in the 'outer ring'. For example, this is the approach currently being adopted in the development of the Crossrail 2 scheme.

**Improving the representation of uncertainty – Model development**

TfL continues to develop its model suite and is in the process of developing a new demand model to replace the LTS tool. The new demand model will include the representation of more modes, in greater detail and have a much more granular representation of individuals and their characteristics. A behavioural model like this poses challenges for accurate forecasting but is an excellent tool to assess 'what if?' scenarios and test uncertainty in how the city might develop. It will give TfL much greater flexibility to expand the 'wheel of uncertainty' and test variable behavioural responses to our schemes and policies.

All the model development work TfL does is predicated on ongoing analysis to understand trends and relationships, to facilitate continuous improvements in modelling capability.