International Transport Forum



Long Run Trends in Car Use



Roundtable Report

OECD

Long-Run Trends in Car Use



Roundtable Report

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Executive Summary

Recent trends in car usage in advanced economies – Slower growth ahead?

1. Introduction

Over the past 10 to 15 years, the growth of passenger vehicle travel volumes has decelerated in several high-income economies and, in some, growth has stopped or turned negative. Drawing from work presented to and discussions at the ITF Round Table on Long-run Trends in Travel Demand, held in November 2012, this paper presents evidence on known causes of this change in growth rates and discusses knowledge gaps, hypothetical explanations and policy implications.

The economic recession and relatively high fuel prices explain part of the decline in the growth of travel but not all of it. Slowing population growth, population ageing and increasing urbanisation contribute to the change in passenger vehicle use in several countries. There is evidence that car use growth has been reduced through policy intervention, particularly in urban areas and sometimes at the national level. Research also reveals remarkable changes in the intensity of car use within some socio-demographic subgroups. Notably, car use per capita among young adults (men in particular) has declined in several countries in recent years. It is as yet not entirely clear why this decline occurs, with competing – or complementary – potential explanations relating to attitudinal and lifestyle changes (e.g. starting a family at later age), to unfavourable economic conditions for increasing numbers of young adults (e.g. rising inequality and higher unemployment) and to increased availability of options other than car use to participate in activities (e.g. more ubiquitous public transport, internet shopping and socialising).

Understanding the determinants of aggregate volumes of passenger vehicle use, and particularly of changes in the weight or the nature of such determinants, is of interest to policymakers and to industry. Designing mobility policies, including but not limited to planning infrastructure development, requires forward-looking analysis of the demand for mobility. If it turns out that the drivers of demand are changing, projection methods need to be revised. The relevance of the issue is not limited to transport in a narrow sense. If car use is likely to grow more slowly than in the past, this may affect decisions on land use and on environmental and climate change policy.

Mobility choices, including car ownership and use, appear to be changing but it is not entirely clear why and explanations sometimes are place-specific. As a consequence, confidence in projections of mobility and car use volumes is undermined and simple, reduced-form approaches, based mainly on GDP and population, further lose their appeal. Rising uncertainty over mobility choices is exacerbated by rising uncertainty over the future development of factors like household income. The rising uncertainty in forward-looking analysis needs to be acknowledged and if some policies are more robust to uncertainty than others, such policies become relatively more appealing.

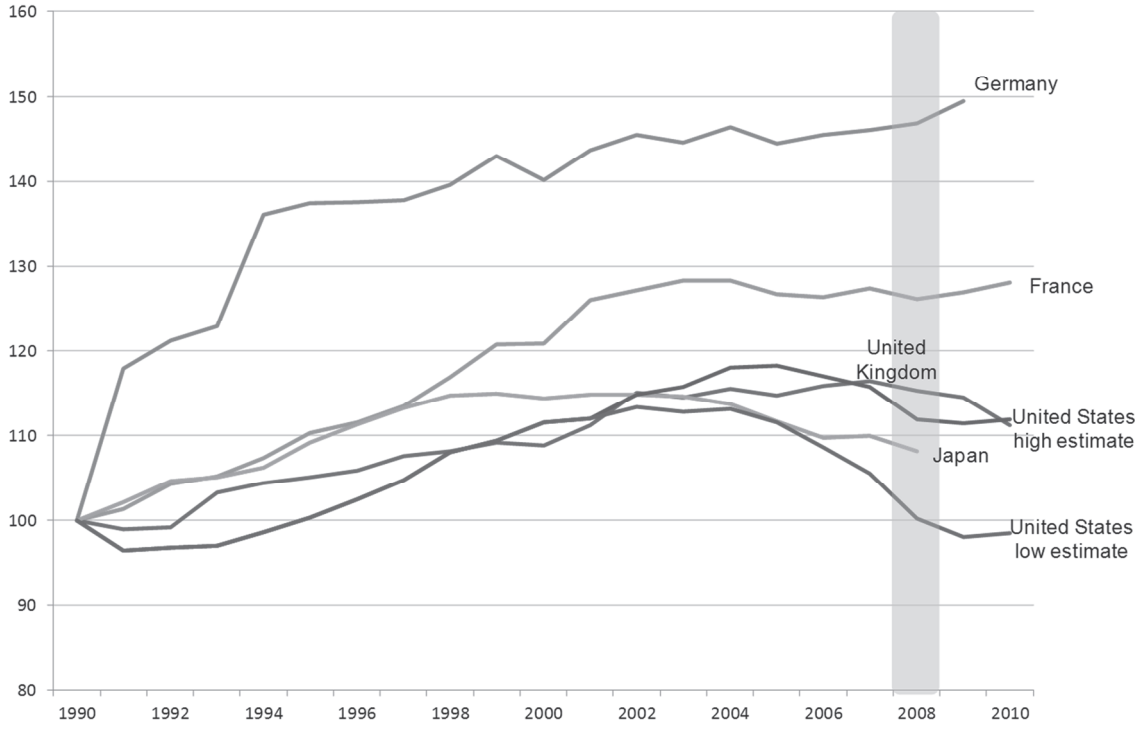
One emerging insight is that transport users are becoming more diverse, both in terms of preferences for lifestyles and mobility and in terms of budgets. Some groups choose less car-oriented lifestyles and the increased availability of other transport modes and online alternatives makes it easier for them to do this. However, in many (but not all[1]) cases such choices require a relatively high level of affluence, for example, because of the relatively high costs of living in urban centres and of choosing high-speed rail and air travel as substitutes for long-distance road travel. Other groups appear to adapt mobility patterns out of necessity. Rising inequality and unfavourable economic conditions, including low wages and high unemployment, restrain budgets for increasing numbers of households.

The rising costs of getting a driving licence and of car insurance exacerbate these constraints, perhaps most for young adults. The affordability of mobility is a growing concern.

2. Indicators of change in aggregate car use volumes

Figure 1 shows an index of passenger-kilometre volumes by car (and by light trucks and/or vans where relevant) in five large, high-income economies, from 1990 through 2010.

Figure 1. **Passenger-kilometres by private car and light trucks, 1990-2010**
(index 1990=100)



Source: ITF statistics ; the high estimate for the USA assumes car occupancy rates remain at the level measured in 2001, and the low one that they decline as of 2001 to the level observed in the most recent household travel survey.

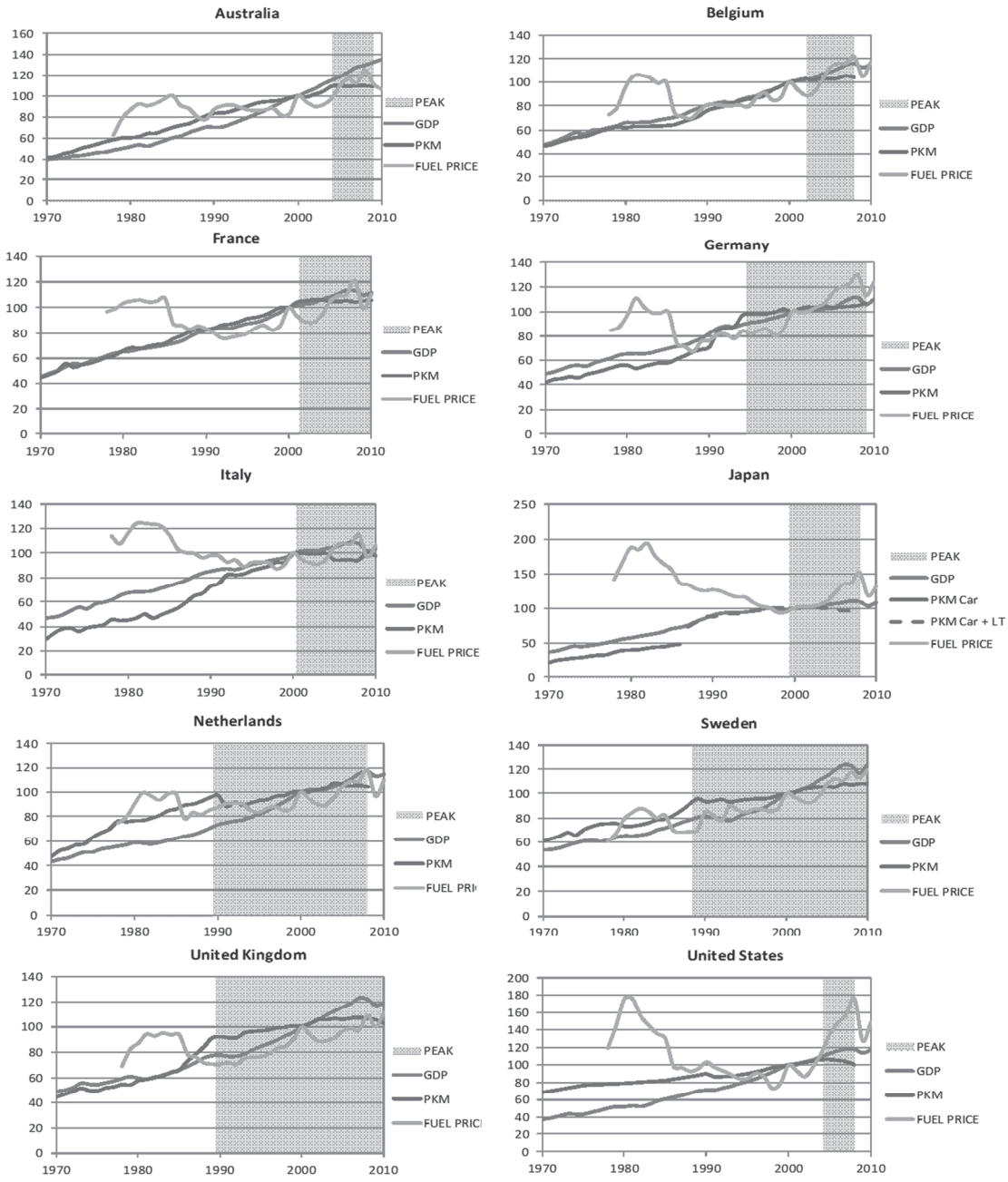
The slowdown in growth is clear in Germany. In France, car use is virtually unchanged since 2003. In Japan, car use has been declining since 1999. In the United Kingdom growth is negative since 2007 and it had slowed down considerably since 2003. The USA displays a decline since around 2005 or even earlier[2].

Figure 2 shows indexes of car use, GDP and fuel prices for ten high-income countries. Since the recession, economic growth has strongly declined in most of the countries shown, and this most definitely has negatively affected car use. However, the slowdown in car use volumes started before the recession, so other factors are at play too. Higher fuel prices have led to reduced car use but do not account for the entire change in the growth pattern either, as lower growth of car use preceded the strong rise in fuel prices in at least some countries. Lower overall growth and fuel prices contribute to lower car use, but do not explain it entirely.

In the countries shown in Figure 2, the rule of thumb that car use grows roughly as fast as GDP appears to be reasonable in the more distant past but it seems to break down in the recent past, with the timing of the change differing between countries.

A quick econometric exercise, see Box 1, supports the interpretation of a slightly weakening relation between GDP and driving, but not a strong decoupling. What other factors than GDP and fuel prices are driving the change in car use growth? Section 3 sets out to answer this question. As will become clear, a diverse set of factors is behind the aggregate slowdown in car use, and these factors are not well captured in a simple GDP – fuel prices – car use logic. Key factors, including population growth, ageing and labour force participation, are well understood but other factors are less tangible and less well described, while nevertheless potentially important.

Figure 2. **Index of GDP, fuel price and passenger-kilometres (PKM) in 10 high-income economies, 1970-2010 (base year 2000)**



Source: Passenger-kilometres are private car travel taken from ITF Statistics, USA data interpolated for missing data points before 1990, Japan data are without light trucks (full) and with light trucks (dotted); fuel price index is a volume-weighted average of gasoline and diesel prices taken from IEA Energy Prices and Taxes and volumes taken from the IEA MoMo database, for Japan only a gasoline price index is used;. GDP data is from OECD National Accounts and in constant 2005 PPP USD; shaded area denotes period when a structural change in private car travel is assumed in the regressions discussed in Box 1.

Box 1. Exploring the relation between GDP and passenger-kilometres travelled

Figure 2 suggests a changing relation between GDP and car travel volumes in several countries, with the change setting in at different points in time. We set up an econometric model to explore this suggestion of change further, using data for ten countries from 1980 through 2007. Results are summarised in Table B.1.

The data form a cross-sectional time series, and we use feasible generalised least squares (FGLS) to account for heteroskedasticity and panel-specific autoregression [AR(1)]. We add country dummies, or fixed effects, to account for unobserved differences between the countries. Year fixed effects can be included as well but make no meaningful difference to the results and are not included in the results shown in the table. Of the various specifications we tried, the following are shown:

- Equation 1: the basic "common sense" model, including a lagged dependent variable to account for inertia in responses to change in explanatory variables, per capita GDP, working age population, fuel price, country dummies (not shown in the table), and a country specific time dummy which is interacted with per capita GDP and equals one as of the year where pkm-growth appears to slow down permanently in that particular country (zero otherwise); we experimented with various definitions of the country-specific time dummy and retained the one for which its effects are strongest.
- Equation 2: extends equation 1 with adult population share in the total population and the share of urban population in each country; we also drop working age population as its effect cannot be separated from country fixed effects with our data (cf. the results of equation 1, for example; we also estimated models without country fixed effects where working age population gives expected results but which are not satisfactory otherwise).
- Equation 3: same specification as equation 2 except that the country specific time dummy is dropped and instead estimation is for 1980-2000;
- Equation 4: same as equation 3 but for 2001-2007.

Equations 3 and 4 are an alternative way to check for change in GDP effects, but cruder in the sense of imposing the same periods for all countries and with fewer data for both separate estimations.

Table B.1. **FGLS estimates with country fixed effects, heteroskedastic panels, panel-specific AR(1)**

dependent variable: pkm	equation 1 basic model		equation 2 additional controls		equation 3 years through 2000		equation 4 years after 2000	
	coefficient	z-stat	coefficient	z-stat	coefficient	z-stat	coefficient	z-stat
pkm lagged	0.905	53.74	0.880	46.76	0.872	35.66	0.423	6.08
gdp/capita	0.126	5.06	0.171	5.8	0.168	4.59	0.217	5.62
country specific time dummy	-0.006	-4.73	-0.005	-3.46				
population 15-64	-0.040	-1.05	-0.064	-1.56	-0.084	-1.37	0.308	3.9
fuel price	-0.041	-3.86	-0.044	-4.08	-0.059	-4.61	-0.109	-8.54
% adult population			0.341	1.73				
% urban population			-0.002	-2.33				
Elasticities	SR	LR	SR	LR	SR	LR	SR	LR
gdp/capita, time dummy = 0	0.126	1.326	0.171	1.425	0.168	1.313	0.217	0.376
gdp/capita, time dummy = 1	0.120	1.263	0.166	1.383				
fuel price	-0.041	-0.432	-0.044	-0.367	-0.059	-0.461	-0.109	-0.189

Note: bold for variables in logarithm, constant and country dummies not displayed.

The regression results are as follows:

- Taking account of autoregression is relevant as expected (see pkm lagged coefficients). Experiments with alternative estimation techniques show that the data allow distinguishing between auto-regression and autocorrelation, with the AR(1) coefficient around 0.11.

- The short-run elasticity and the lag are estimated with enough precision to obtain significant elasticity estimates, in all equations. GDP elasticities of pkm are well above 1 in the long run, for equations 1 and 2 (see lower half of table). In equation three ("early period"), the long-run elasticity is 1.313, and in the recent period it is 0.376. This suggests a strong decline in the income elasticity of pkm, in line with what visual inspection of Figure 2 suggests for at least some countries. However, this result comes about through the strongly reduced lagged effect, as the short-run elasticity estimate actually has increased.

- Equations 1 and 2 identify a significant change in the elasticity as well, through the country specific dummy. However, the change is economically small, as can be seen in the lower half of the table (e.g. in equation 2 the Long-run elasticity is 1.425 initially and 1.383 more recently).

- The long-run fuel price elasticity is -0.432 in equation 1 and -0.367 and is precisely estimated in both cases. The orders of magnitude are in line with literature, though perhaps on the high side. Equation 4 shows a much lower elasticity. It is possible that the role of fuel prices is not well identified in these equations and that this helps explain the differing role of income in them (e.g. the strong decline in income effects is really a fuel price effect).

- The effect of the share of working age population and of urban dwellers is not precisely estimated in the second equation, but signs are as expected.

To conclude, if the results of equations 3 and 4 on the changing income effect were robust, the models of equations 1 and 2 should reproduce them more strongly than they in fact do, because the country-specific dummies allow more flexibility in changing GDP effects than the models of equations 3 and 4. Hence, we find evidence for a small decline in income elasticities, but not of the order of magnitude that a quick glance at Figure 2 would suggest.

We do not interpret this as conclusive regarding the absence of such a strong change. Instead, it seems to us that an aggregate model focusing on GDP effects and fuel prices is too crude to capture the diversity and various dynamics underlying aggregate car travel demand and how it changes – a conclusion that is strongly supported by the discussion in Sections 3 and 4.

3. Diagnosis

3.1 Potential explanatory factors and "stylised facts"

The growth rate of passenger vehicle travel (vehicle-kilometres) has declined in several rich countries, and has dropped to zero or turned negative in some. Aggregate passenger vehicle travel is the sum of car use in a large number of "markets for passenger vehicle travel", where in principle a market can be defined for every situation for which a sensible demand and cost relation is conceivable. For example, the market for morning peak hour commuting by car in a given city can be distinguished from the market for morning peak car use for other purposes, and from off-peak travel, and from car use in other cities and non-urban areas, etc. Analysing changes in demand (willingness to pay at given incomes) and costs (of access to a car, the costs of which are shared between markets, fuel and time) would establish why quantities demanded in these markets change. Combined with information on the size of the markets, the change in the aggregate outcome could then be reconstructed.

In practice, many studies implicitly apply the logic just outlined, but the resolution to which the analysis can be refined is limited by data availability. Aggregate travel is defined as the sum of travel by groups defined through a set of socio-demographic characteristics (age, gender, income, employment and education, urban or not, etc.). Data constraints impose the assumption that households or individuals in these groups are rather similar, even though the various characteristics are frequently considered separately rather than simultaneously, and even though recent work on travel choices suggests that unobserved heterogeneity is considerable even in the most sophisticated studies. Most analyses define individuals as the basic unit, and travel-per-capita as the basic measure, and then consider changes in travel patterns within the group. Changes in the sizes of groups to which individuals belong depend on the evolution of demographic, socio-demographic, and economic variables used to distinguish groups. These variables are exogenous to the analysis, which of course does not mean that their future path is necessarily known with a high degree of confidence.

The impact of socio-demographic characteristics on travel demand, and the change in that impact, can be described with a set of "stylised facts", which are generalisations and simplifications of empirical observations that are not valid for all specific cases but that are intended to capture average or modal regularities. It is important to distinguish stylised facts from hypothetical explanations, and case-specific analysis and policy development requires careful consideration of their applicability. Section 3.2 reviews case-specific work in more detail. The following stylised facts are mostly useful as starting points for detailed empirical analysis:

- Age: driving first rises and then declines with age. When people retire they significantly reduce their annual mileage, typically by about half, and annual mileage tends to decline as they age further. As a result, there are likely to be large reductions in vehicle travel as the Baby Boom generation ages. Although they drive more than past cohorts did in retirement (because licence-holding and car-oriented attitudes are more common in these cohorts and because they are on average healthier at higher age than older cohorts), they still significantly reduce their vehicle travel. Older adults now drive more than older adults in the past, but this effect is likely to phase out in the future. Conversely, the increase of driving at younger age is slower and smaller for younger cohorts, a phenomenon that is only partly understood.

- Gender: men on average drive more than women, but the difference is declining as car use in some cases declines among men, and rises among women. Furthermore, in some places the role models that partly determine mobility patterns are converging.
- Income: higher disposable incomes usually translate into more mobility and more car use[3], but the rate of increase declines at high incomes and apparently car use sometimes is lower for the most affluent than for lower income groups. Zero or negative growth at very high incomes can be the result of substitution towards faster transport modes, lower-mobility location choices (e.g. expensive downtown locations), of low or zero additional benefits from more mobility (saturation), or of the opportunity costs of spending more time in transport becoming very high[4].
- Saturation of aggregate vehicle ownership and travel: during the Twentieth Century, vehicle ownership and travel grew from virtually zero in 1900 to high levels which may be close to saturation levels in most developed countries by 2000. These levels vary from one geographic area to another (neighbourhood, urban region, country, etc.) due to factors including the quality of transport options, transport pricing and land-use development patterns.
- As affluence rises, proportionally more travel is for leisure purposes. Such travel may be more car-oriented than commuting because of stronger spatial dispersion of destinations and hence lower availability of public transport. Non-commuting travel also is more price-elastic, so may change strongly as time and money costs of using cars increase.
- Employment and education: working tends to involve commuting and often car use, whereas schooling is associated with lower car use. Rising female labour force participation has translated into increased car use, but the rate of the increase in participation declines, so this effect may diminish in the future. Increased take-up of opportunities for higher education has a negative effect on car use. This effect too can weaken as take-up of higher education grows more slowly.
- Access to cars: individuals can have access to one or several cars owned by the household they belong to, or to a company car, or via car sharing systems, and these accessibility conditions affect the intensity of use. Access to cars requires holding a driving licence, and licence-holding becomes more difficult with more stringent regulations and rising costs. Driving licence holding is declining among younger individuals in some countries, whereas it increases for older age groups. Access to company cars, and sometimes to cheap fuel, has risen in some advanced economies, presumably as a response to the high fiscal burden on labour. Since users are not directly confronted with marginal costs, this trend translates into higher car use. More recently, fiscal distress leads to partial dismantling of the favourable treatment of company cars and their use, with lower usage as a consequence.
- Location: car use is higher where density is lower and is particularly low in urban cores, because there are more destinations per unit distance and because alternatives to the car are more commonly provided.
- Access to alternative transport modes: as other modes become more ubiquitous and/or cheaper, car use declines. Urbanisation is associated with less car use because with higher density more destinations are accessible per unit of distance, which leads to shorter driving distances and makes other modes (public transport, walking and cycling) relatively more appealing. Furthermore, public transport availability is often higher in denser areas. Mobility policies in several urban areas are becoming less accommodating to car use, with appreciable reductions in road and parking space and increased support for alternative transport modes.

- Immigration: increasing shares of foreign-born inhabitants lead to lower car mobility (controlling for income and predominantly urban location choice), perhaps partly because of habits, and because visiting friends and relatives in faraway places is less easily done by car (and more by plane or train); the changing geography of friendship and the associated mobility choices take place to a lesser extent outside immigrant communities as well.

3.2 Evidence and emerging explanations

Several studies report on similarities (but not simultaneity) in aggregate trends in car use in a number of high-income economies, see for example, Millard-Ball and Schipper (2011); ITF (2011), but systematic comparisons on a disaggregated level are scarce (see, however, Newman and Kenworthy, 2011). However, disaggregation is indispensable as aggregate outcomes are the result of change in opposite directions and not of an overriding common factor. Kuhnimhoff *et al*. (2012) provide a systematic comparison of six countries (France, Germany, Great Britain, Japan, Norway, USA) on the basis of travel survey data from around 1995 and 2005[5]. Their main findings are as follows:

- In itself, population ageing has a negative impact on car travel in all studied countries, and most strongly so in Japan and Germany.
- However, the negative effect of ageing is counteracted by the increase in car ownership at higher age in all studied countries except for the USA. In France, the UK and Japan, this compensating positive effect is larger than the negative effect of pure ageing, meaning that travel per capita rises. In Germany the two effects cancel out. The difference between the USA and the other countries probably is related to earlier mass motorisation, so that the rise in ownership at higher age took place earlier there, with as a consequence a smaller upward effect on driving now. Kuhnimhoff *et al*. (2012) hypothesise that this difference is key in explaining the larger drop of car use in the USA compared to the other countries studied. Dejoux *et al*. (2009) suggest that the USA pattern is general to North America and differs from the European one.
- Car ownership among young adults has declined in Norway, the UK, Germany, and the USA. It increased, by contrast, in Japan. In the middle age groups, there were declines in Germany and the USA and increases elsewhere.
- Reduced car use among young adults is key to explaining the aggregate pattern in Germany, the UK, and Norway, in the sense that without this change and all else equal there would have been no decline or even an increase in car travel in those countries. This conclusion does not apply to France, Japan.
- The effect of mode choice differs between countries. In Germany and the UK, modal shifts away from the car contribute strongly to reduced car use. In Japan the effect is small, and in France and Norway there was a shift in the reverse direction.

In short, these results emphasise the importance of compositional effects in explaining aggregate car use, they reveal heterogeneity among countries, and show the need for a better understanding of car use among young adults. We summarise findings from some country studies against this background.

Taking all modes together, distances travelled per person in Great Britain levelled off around 1998 and declined in 2007. Trip distances rose while the number of trips fell. Rail travel has increased

strongly. For car use, the number of trips, their length, and occupancy rates, were roughly constant from 1995 through 2007. A comparison of British travel survey data of 1995, 2000-02 and 2005-07 (Le Vine and Jones, 2012) reveals that the limited change in average car driving per capita over the period is the result of a strong decline in men's travel (reduced mileage among drivers, not fewer drivers) and an increase in women's licence-holding and travel (although car use for men remains about twice as high as for women)[6]. Travel declined most for the youngest men, was stable for men aged 50 to 59, and rose most for the oldest. For women aged 20 to 29, travel was stable and it increased most strongly for the oldest. There also is evidence that persons born outside the UK travel less than those born in the UK, although other characteristics (living in London, gender) explains part of that difference. The decline of car driving over time is visible in all income brackets except the lowest, and is stronger as income is higher. Nevertheless, higher incomes remain associated with more driving. The largest decline in car travel is for shopping and visiting friends and relatives, which some see suggestive of a change induced by choice (perhaps facilitated by the rising availability of online alternatives to travel) but which also could be the result of tighter budget constraints.

Remarkably, with the exception of men in their twenties, the decline in men's travel is largely explained by a drop in company car use, a phenomenon very likely caused by the less favourable fiscal treatment of fuel use for company cars. The decline of company car use can explain the entire levelling off of car driving since the 1990s. It is plausible that the company car effect is concentrated among higher incomes, so that the stronger decline in driving at higher incomes is at least partly the same company car effect. The largest reductions in company car use are among professionals and employers or managers. Car travel also fell in London.

Company car use and the London case apart, there has been no decline in travel among those aged 30 and above. The decline of car travel of men aged 20 to 29 is large – about 1 800m/year, and is mostly attributable to personal car use (the share of company cars in this age bracket is small). Half of the decline is due to fewer people driving, and half to reduced mileage by drivers. About one-third of the decline is for trips to visit friends and relatives. It is as yet unclear whether this decline reflects postponement of car use to a later age or whether lower car use will persist in this cohort.

In the Netherlands, total car-kilometres by drivers levelled off starting in 2005, and car-kilometres by passengers declined. Car ownership kept rising and so did licence-holding except for 25-29 year olds. Van der Waard *et al*. (2012) suggest this points to very weak signs of saturation at best. Mobility among young adults fell, notably for 18-29 year olds (as of 1995) and more moderately for 30-39 year olds (as of 2005). This is both because of group size and because of changes in group behaviour. Across modes, men aged 18-29 travelled 16% less in 2009 than in 1995, while women travelled 6% more (but their travel as car passengers declined). These changes appear to be linked to strong reurbanisation and to a rising share of students and declining share of workers in this age bracket. In the Netherlands, public transport is very cheap for students, and this group represents a third of public transport patronage. Change in this policy, which is contemplated for 2015, might have a substantial effect on students' travel choices. The status of car ownership remains high among young adults but it is not known if it nevertheless fell compared to earlier cohorts. There is no evidence of a shift in preferences for cars towards smartphones or tablet computers. The Dutch do travel more abroad, particularly by plane, but the share of international travel in total travel is too small for this to explain the decline in national mobility.

For the USA, Davis *et al*. (2012) emphasise the role of young adult's travel choices in explaining the observation that per capita car travel started declining in 2004, and is now 6% below its highest historical level. Household travel survey data show that per capita car travel in the age group 16 to 34 fell by 23% between 2001 and 2009, with the number of trips per driver declining by 15% and the average trip distance by 6%. The share of 14 to 34 year olds without a licence increased from 21% to

26% over the same period. Increased use of other modes (walking, cycling, and public transport) suggests a degree of substitution, and this substitution is facilitated by increased urban living. However, substitution by other modes is not very strong, so that the reduction in travel by young adults is strong. Furthermore, travel at higher age is not growing very strongly anymore in the USA (as travel-intensive habits permeated earlier in the USA than elsewhere). In the aggregate, the result is particularly strong decline in car travel growth compared to other countries.

Survey evidence supports the view that technology and social media are seen as substitutes for physical travel, particularly among the young. Barriers to driving, including high gas prices and tougher licensing laws, matter too. Lower incomes explain part of the decline as well, but likely not enough to expect a turnaround in travel choices if and when income growth picks up. In short, Davis *et al*. (2012) and Puentes (2012) see sufficient evidence to hypothesise that there is an enduring trend toward lower car use. Puentes (2012) argues that the economic development model in the USA is transitioning from a consumption-oriented approach to one that relies more on production and exports. Growth is increasingly concentrated in metropolitan areas, and within these areas real estate development and land-use patterns are changing, with less urban fringe and car-oriented development. This contributes to slower growth in car use (but perhaps stronger growth in freight traffic).

For France, Madre *et al*. (2012) emphasise contrasting developments between large urban areas and less dense regions. In large urban areas, fewer car trips were made per head in 2008 than in 1994 and they were of shorter duration. The transition from a double to a single commute per workday appears to explain a considerable part of that change. Car ownership declined, and there was a slight decline in licence-holding among young adults (at least partly because of the abolition of compulsory military service). These changes took place irrespective of income levels. Fuel prices increases around 2000 play a role in explaining the declining growth rate, although in greater Paris the decline started well before 2000, and earlier at higher income levels. In lower density regions, there are more cars and they are used for longer trips. The slowdown to zero of car use growth is expected in these regions too, but car use will remain higher. Currently, data do not allow distinguishing between a "delayed rise car use among younger adults" and "permanent reductions of car use among currently young cohorts".

Distances travelled in Japan by air, rail, and car started a gradual decline in 2004, see Hyodo (2012). Car-kilometres fell as of 1999, as a result of shorter trips and despite an increase in the number of trips and of passengers. Low growth, translating particularly into rising numbers of low income households, and high gas prices drive part of this evolution. Other changes, including later age of marriage, smaller households, and of course population ageing and a decline of the total population (since 2009) work in the same direction. There are relatively fewer younger drivers in more recent years, and the relative decline of younger female drivers is particularly pronounced. Travel in the Tokyo conurbation is still on the rise, partly driven by a larger population.

To summarise, the decline in growth rates of passenger car use is the result of group size effects and within group changes. The relative importance and sometimes the direction of the effects differ between countries, and country-specific effects matter. There are similarities between countries, but they are not strong enough to generate simultaneity. Furthermore, strong disparities occur within countries, notably between the largest cities, other cities, and rural regions. Population ageing and low or negative population growth have negative effects on mobility growth, although growing car access and use among older cohorts puts a brake on this effect up to now, except in the USA. Access to cars and car use among young adults declines in several countries [among the six countries analysed by Kuhnimhoff *et al*. (2012), France and Japan are the only countries where young adults do not contribute to declining car use], and it is not clear to what extent this is a transitory or a permanent change. Apart from the USA, where it was high to begin with, there are no strong indications that the

status of the car has waned. Gender differences in car use and broader mobility patterns appear to be declining.

Urbanisation has a negative effect on car use in several countries, and contrasts in mobility patterns between large metropolitan areas and less dense cities and rural areas appears to be sharpening. Increasing participation in higher education plausibly leads to – at least – a delay in taking-up car-intensive mobility habits. Correspondingly, if this increase phases out, the downward effect on car use declines. More generally, car-intensive lifestyles appear to occur later in life more often, which would mean that lower car use at younger age is partly a persistent effect to the extent that the lifestyle change is persistent. Higher incomes lead to more car use, although at high incomes the effect appears to be weaker and may even turn negative. However, the causes of this declining income effect are unclear: rising opportunity costs of spending time in transport may matter; there can be substitution to other (faster and more expensive) modes; but there can also be confounding with high-density location choices and the reduced appeal of company cars.

The available evidence provides insight into characteristics that are correlated with car use, and on how the role of these characteristics changes over time and is place-specific. But insight into cause and effect remains limited, because characteristics are often considered in isolation whereas they ideally should be considered simultaneously (e.g. income and location, company car access and income). Also, characteristics may be related with underlying variables rather than being explanatory in themselves. For example, reduced car use among young adults can be the consequence of changing attitudes and/or of declining disposable income among subgroups of young adults. It is, in other words, not entirely clear to what extent the change in travel is mostly the result of choices or of constraints. Both likely play a role, and rising heterogeneity within the young adult population may mean that for some subgroups constraints dominate and for others choice is the main driving factor.

The impact of IT applications on car and other travel remains unclear. Several effects, in different directions, are plausible: a shift away from cars as other modes allow online activity more easily, lower travel demand following the emergence of IT-enabled alternatives to traditional vehicle ownership (e.g. car-sharing), a reduction in travel demand as some activities no longer necessarily require physical travel, increased availability of cars for other purposes as telecommuting rises, rising average trip distances as location farther away from physical travel destinations now is less costly, etc. The net effect on travel is unclear in principle, and available evidence is inconclusive. It was pointed out that much of the evidence appears outdated, and updating it is of considerable interest, not least because newer IT-induced innovations likely have qualitatively different effects from earlier ones. The earlier generation of research focused on home-based personal computing, whereas the dominant recent trend is for multi-instrumental portable mobile internet access, which changes usage patterns and potentially interactions with mode-choice. Also, changing choice sets do not necessarily lead to changing choices, but do create larger scope for change if behavioural incentives (e.g. prices of car use) change and if preferences change (e.g., the distribution of family relations and friendships has become more geographically dispersed, partly because of immigration, and this affects what social connectivity models are chosen).

Another example concerns the impact of urban living on car use. To what extent is the negative effect on car use the result of self-selection? If individuals or households that prefer high-density and low car-use lifestyles are disproportionally present in urban areas, then measured effects of urban living should not be expected to be equally large if other individuals or households, with different preferences, move to urban areas (see, for example, Golob and Brownstone, 2009, and Kim and Brownstone, 2010). Furthermore, transport choices in urban areas are affected by policies. Increasing numbers of cities are adopting less car-oriented transport policies, and this discourages car use. The point here is not to evaluate the merits of such policies, but simply to acknowledge that car-use

choices are contingent on policies, not just on drivers' characteristics and preferences. Data limitations make it difficult and often impossible to evaluate the relative importance of such competing or complementary explanations, and this in turn means that projections on the basis of current observations of decline are subject to high uncertainty – uncertainty that needs to be acknowledged.

4. Lessons for policy and projections

Aggregate car use is the result of location and travel choices made by a diverse set of (potential) car users. These choices depend on preferences, incomes, and prices of various transport options and alternatives to travel. Preferences are subject to change, and there are signs that car use is less of a priority in groups preferring urban lifestyles and more reliant on online networks. Income growth is now less self-evident, with rising inequality and weaker growth prospects in many OECD economies. Prices are partly determined in markets and partly depend on transport policies broadly defined, where the latter now often are less favourable to car use than before. Together with ageing and saturation of access to cars, these changes contribute to slower growth of car use. They also reflect increasing heterogeneity among potential car users. Whereas car ownership and use was a common aspiration for most, and an aspiration that was satisfied for increasingly many, it has become a somewhat less universal goal, and perhaps one that is more difficult to reach for some.

Aggregate car travel is a variable of some policy interest, as it is roughly indicative of a country's resource needs for car transport (including road and parking infrastructure, energy, etc.), of environmental and climate change impacts, and of the sector's tax revenue generating capacity. Aggregate travel is particularly relevant for gauging investment needs when transport and economic growth are high and networks are under development, as it provides an indication of overall resource needs. In more mature economies, decisions on where and how to invest in infrastructure or are driven less by overall growth than by specific needs in the network. It is, for example, anything but obvious that slower growth in aggregate car use changes the case for relieving current bottlenecks.

The relevance of the analysis discussed above then is more in the message that disaggregation is needed to understand change, and that local patterns can diverge from the aggregate trend. The priority is not to establish with maximal confidence whether aggregate travel will grow, stagnate, or decline, but to understand drivers of growth better. The keywords here are rising heterogeneity and rising uncertainty. Rising heterogeneity means that travel choices are less well predicted by basic socioeconomic characteristics. Since choices are harder to predict, projections are subject to rising uncertainty. Deciding on policy is more difficult in a more uncertain environment. Policies that are robust to uncertainty, i.e. that make sense in the widest possible set of possible outcomes, gain in appeal, and identifying such policies is of key interest.

Goodwin (2012) argues that the broad class of "smart" and less car-oriented mobility policies fares better than standard policies that can be characterised as accommodating towards car usage aspirations. At any rate, the need to select policies that consider overall benefits ("balanced mobility policies") rather than focussing on direct user benefits is strengthened by the rise in uncertainty. Appraisal, in the form of comprehensive cost-benefit analysis of policy strategies rather than just projects, is instrumental to such a policy approach. Of course, the case for such policies is not contingent on any particular pattern of development of car use, but on the need to align individual

travel aspirations and choices with their social costs and benefits. This does not mean that the observed changes are irrelevant to the debate. First, to the extent that user preferences diverge less from what is socially beneficial, as is the case according to some readings of the observed change in aggregate car travel, implementing balanced mobility policies will meet with less resistance. Second, there are several indications that, apart from a possible change in preferences, behavioural change now is easier given the changing nature of travel (a larger share of non-work trips, for which own- and cross-price elasticities may be larger) and the increased availability of alternatives (more public transport, more cheap air travel, more online activities, etc.)[7]. Such changes may translate into more flexibility in travel choices, so that higher prices for car travel result in larger declines of that travel. This suggests that pricing reforms (more efficient road, parking, fuel and insurance pricing, and less favourable company car policies) can be more effective at reducing vehicle travel and encouraging use of alternative modes, and road tolls will generate less revenue than assumed in many travel models (see, for example, Williams-Derry, 2011). It was noted that in an ageing population the demand for travel changes, but also the weight of the elderly in decision-making rises, and this may lead to mobility policies that align more with their needs and preferences.

Revenues needed for maintaining the integrity and quality of current road networks, let alone of upgrading them, do not diminish in proportion to slower growth of network usage. If transport infrastructure is to be funded from user charges, slower or zero traffic growth will need to be accompanied by increasing charges (especially if user charges are mainly fuel taxes and fuel economy improves, as is clear from the current experience in the USA). If funding is from general revenue, transport tax revenues will grow more slowly or stagnate, unless rates are raised and/or new taxes introduced. In either case, the possibility of prolonged slow growth of car use volumes adds to the already considerable set of arguments for reforming the funding basis for transport infrastructure.

The discussion up to now has focused on high-income economies. In developing economies, the rule of thumb that mobility and in particular car use will develop in line with GDP as long as policies do not point strongly in the opposite direction, remains broadly applicable. Furthermore, strong natural population growth and rural migration to cities where motorisation is often twice that of rural areas due to higher incomes, will induce pressure towards higher motorisation. Possibly, attitudinal changes related to availability of online activities could curb growth at an earlier stage than in high income economies, and faster urbanisation leading to congestion can reduce growth in car use. However, this curbing effect will not necessarily materialise in the absence of policies that disincentivise car use. Balanced mobility policies conceivably could induce levelling off of car use at lower per capita car use volumes than are observed in currently high income economies (see also Litman, 2012b). Providing public transport is not enough for this – car use itself needs to be regulated through appropriate prices, and land-use policy. And even when car use is inconvenient because of high congestion and high purchase prices, the preference for personal mobility may lead users to turn to two-wheelers (motorcycles, in particular), as currently is the case in Asian and Latin-American cities. We may observe a downward tendency of car use due to ageing but not before 20 or 25 years (Madre and Bussière, 2012).

Linking back to Section 2, the disaggregate analysis shows that the change in aggregate levels of car use is the result of various changes, in different directions. This suggests that aggregate projections on the basis of GDP and fuel prices may be misleading, as they do not capture these underlying changes. It could be argued that the aggregate fuel price elasticities are the result of the changes observed and therefore are a reasonable shortcut for forward looking analysis, but our reading of the evidence is not in line with such an interpretation. It is difficult to see how the range of explanatory variables considered could all be captured in a single fuel-price elasticity.

5. Conclusion

In past decades, the aggregate demand for passenger travel has developed roughly in line with per capita GDP and population growth but there are strong signs that this close connection is weakening in advanced economies. In particular, *car* travel volumes in some countries stopped growing in the recent past or have declined despite continued growth in GDP. This paper considered evidence that helps us understand why this is so. We find a range of explanations that are understood, and some hypothetical explanations that are plausible. A combination of factors explains the aggregate trend but some are likely to be more persistent than others. Policy interventions also make a difference. While some explanatory factors are fairly well understood (e.g. ageing and cohort effects), others are more uncertain (e.g. the role of information and communication technology). The relative importance of different factors also differs between countries and between places within countries (e.g. urban and rural regions). Separating out the various factors is important for making useful projections of travel demand and for examining specific issues of transport policy (emissions mitigation, congestion management, etc.). Is the phenomenon transitory or is it permanent? This holds for economies where the demand for car travel has levelled off recently, but potentially also for developing economies. The latter may experience some of the changes apparent in high income markets at lower levels of incomes (e.g. because of more rapid urbanisation and policy intervention), although for the coming decades rapid increases in motorisation are expected.

Notes

1. For example, incomes in many US city cores are relatively low, and more generally the sum of commuting and housing costs in urban centres may not differ strongly from that in suburbs.

2. Two lines are shown for the USA, with the upper one assuming that car occupancy rates remain at the level measured in 2001, and the lower one assuming they decline as of 2001 to the level observed in the most recent household travel survey. The true path is most likely in between those two bounds.

3. Mobility and car use are "normal goods", in economic parlance. Note that cross-sectional and time-series income effects can differ, so that evidence on differing effects in a cross-section do not necessarily apply when analysing income growth over time.

4. An extreme case would be that there is a maximum to the time individuals are prepared to spend in transport. Evidence for such a maximum is weak on the disaggregated level (Mokhtarian and Chen, 2004), and the more general case of rising opportunity costs is sufficient to explain declining income effects.

5. Although not apparent from this review, establishing comparability between the national travel surveys of the six countries is a major contribution of the study.

6. Le Vine and Jones (2012) note that most road traffic growth since the 1990s comes from greater van traffic, an observation for which the causes merit further exploration.

7. Elasticities are not constant over time, although data limitations often lead to time-independent estimates. Over the long run, some studies (e.g. Small and Van Dender, 2007) found a declining elasticity of mileage with respect to the fuel price. More recent evidence suggests a renewed increase (e.g. Litman, 2012a), a finding consistent with a framework in which elasticities rise with higher fuel prices and decline with higher income, but also with arguments discussed in this paper regarding changing habits and the rising availability of alternatives.

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Chapter 1

Are we heading towards a reversal of the trend for ever greater mobility?

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Abstract

In most industrialised countries, it can be seen that urban mobility and car traffic have stagnated since the early 2000s. In France, the report on traffic conducted by the National Transport Accounts Commission shows a similar break in the trend, which was confirmed by household travel surveys (EMDs) in most major cities, including Lille, Lyon and Strasbourg, and later by the National Transport and Travel Survey (ENTD), which shows that the trend can be attributed primarily to people living in large urban areas and provides an overall view of mobility: trips have become less frequent (with unbroken workdays) and less exclusively taken by car (as more young adults adopt multimodal behaviours), and car ownership is decreasing in the centre of greater Paris, as, for that matter, in the centre of London.

Does this levelling-off of traffic suggest that the saturation point is near (with a decoupling of traffic and income trends in the most densely populated areas or above a certain standard of living) or, rather, a cancelling out of opposite trends (continued growth in rural and suburban areas and decline amongst residents of the most densely populated areas)? Is this a structural phenomenon (population ageing, etc.) or a cyclical one linked to rising and volatile fuel prices and the recession?

We shall explore these issues in the light of data collected in France, supplemented by selected data from other developed countries, and then move on to a comparison with a number of Mexican cities in order to consider the extent to which, and in what timeframe, these trends could spread southward to the emerging economies.

Keywords: Outlook, mobility, car ownership, reversal of trend.

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1. Introduction: Stocktaking in the developed countries

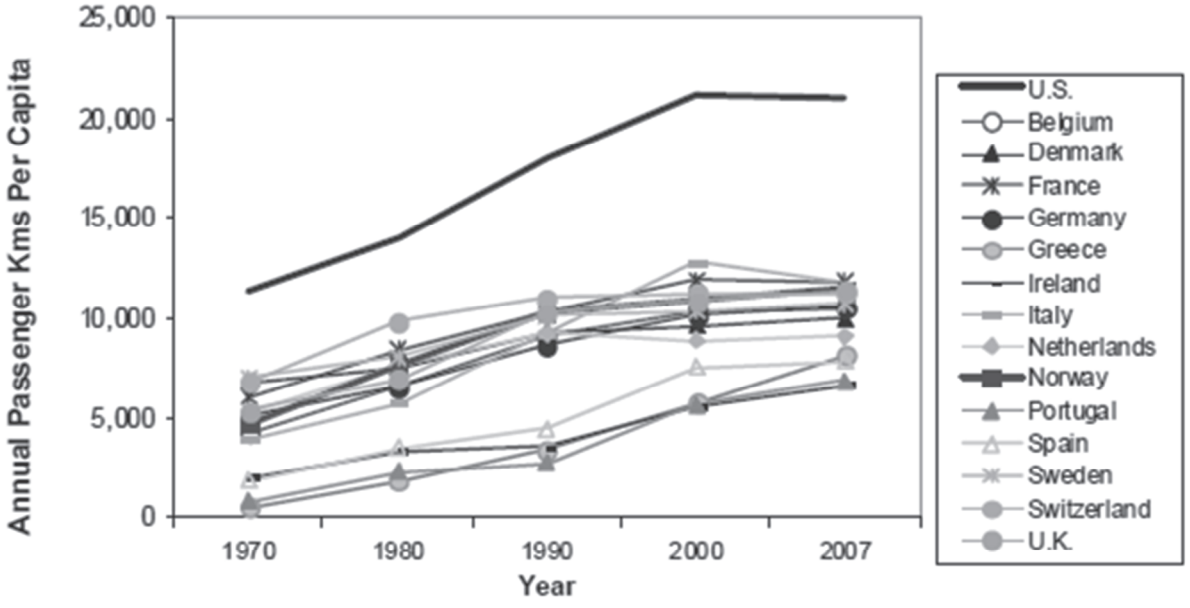
Internationally, after expanding rapidly in the 1960s and 70s, growth in road traffic (as a per capita average) slowed and seemed to approach the saturation point in a number of industrialised countries (Litman, 2009; Millard-Ball and Schipper, 2010; Newman & Kenworthy, 2011) (see Figure 1). The Australian Bureau of Infrastructure, Transport and Regional Economics, which has compiled a long series for 25 countries, explains this trend as a reflection of fuel prices and economic activity, as well as a time-related saturation effect (BITRE, 2012). A comprehensive analysis of global transport demand trends over the next forty years was presented by the JTRC/ITF in May 2011 in Leipzig (OECD/ITF, 2011). Having noted an apparent saturation in the developed countries, this working group nonetheless took a critical view of extrapolating demand on the basis of this assumption alone, stressing the need to take account of such other factors as rising fuel prices and the distribution of wealth, as well as the scope of future transport demand trends in the emerging economies. Our preliminary research on two Mexican cities shows that this levelling-off of mobility could occur there in around 2030.

In most developed countries, the proportion of people holding driving licences at any given age had always been on the rise as compared with previous generations, and the increase had been greater for women than for men, thus indicating that their respective behaviour patterns were becoming more similar. It has now been found that the licence-holding percentage among young people has started to decline in some 10 countries (Sivak and Schoettle, 2012), in parallel with the development of the Internet, and that this is especially perceptible in the case of young males; these countries are located in North America (Canada and the USA), where the spread of the automobile began in the 1930s, in the Nordic regions (Norway and Sweden, but not Finland), in western Europe (United Kingdom, France and Germany, but neither Switzerland nor the Netherlands), and in the most densely populated areas of the Far East (Japan and South Korea); the flourishing of car ownership is too recent in central Europe (Poland, Latvia), and to a lesser extent the Mediterranean countries (Spain, Israel), for such a phenomenon to be observable yet. In France, the decline in the number of licence-holders could be attributed to the abolition in 1997 of compulsory military service, which had enabled young men to start driving at virtually no cost to themselves (Avrillier *et al.*, 2010).

According to a comparative study of young adults (aged 20 to 29) in six industrialised countries (Germany, United Kingdom, France, Japan, Norway and the United States), between 1975 and 2010,

in most countries, the average distance travelled peaked around the end of the 1990s, or at the beginning of the 2000s in the United States, and subsequently declined (Figure 2). Thus, young people are less likely to have a driving licence and to travel exclusively by car than youth in the previous generation (Kuhnimhof *et al.*, 2012). There are a number of possible explanations for this phenomenon: the fact that a growing proportion of young people pursue higher education, which defers their entry into the labour market; the tendency to start a family at a later age; rising fuel prices; the introduction of demand-management measures to reduce car traffic in cities; and lastly, a change in mentalities.

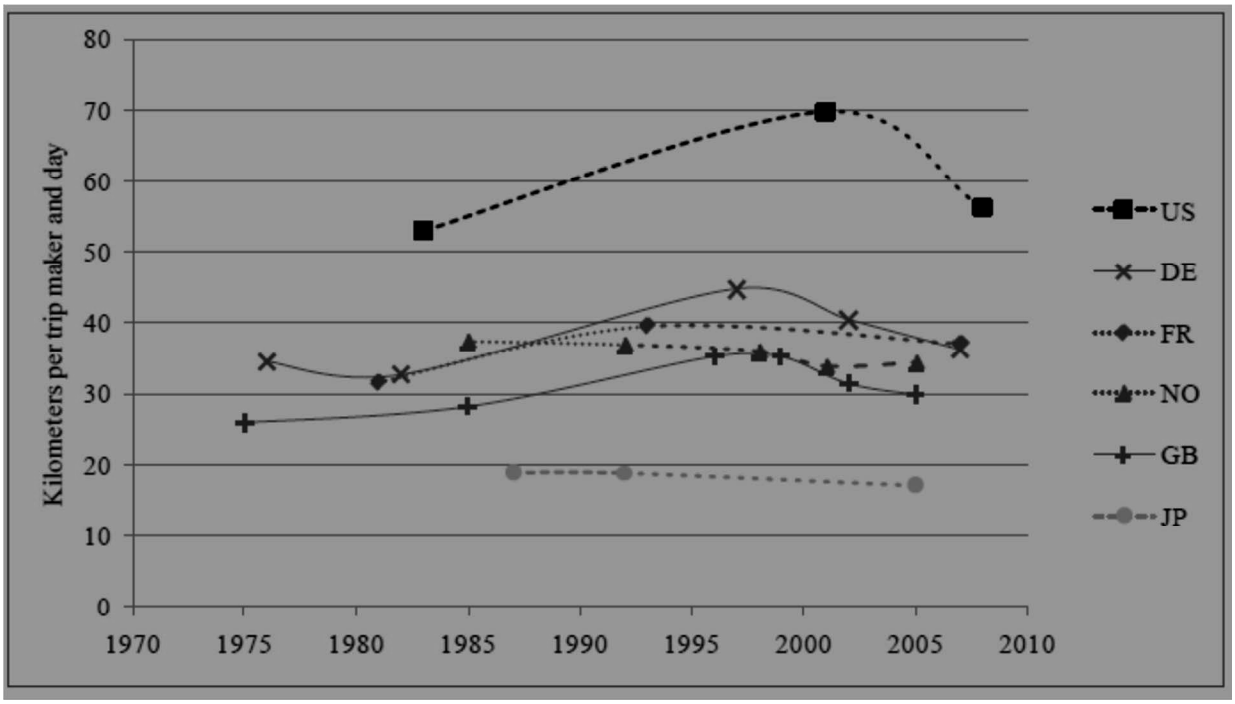
Figure 1. **International vehicle travel trends**



Per capita vehicle travel grew rapidly between 1970 and 1990, but has since leveled off in most OECD countries, and is much lower in European countries than in the U.S.

Source: Litman, Todd (2009), *Evaluation of Public Transit Benefits and Costs. Best Practices Guidebook.* Victoria Transport Policy Institute, www.vtpi.org.

Figure 2. **Vehicle-km trends (car driver and car passengers) per traveller, per day for young adults aged 20-29 (six countries)**

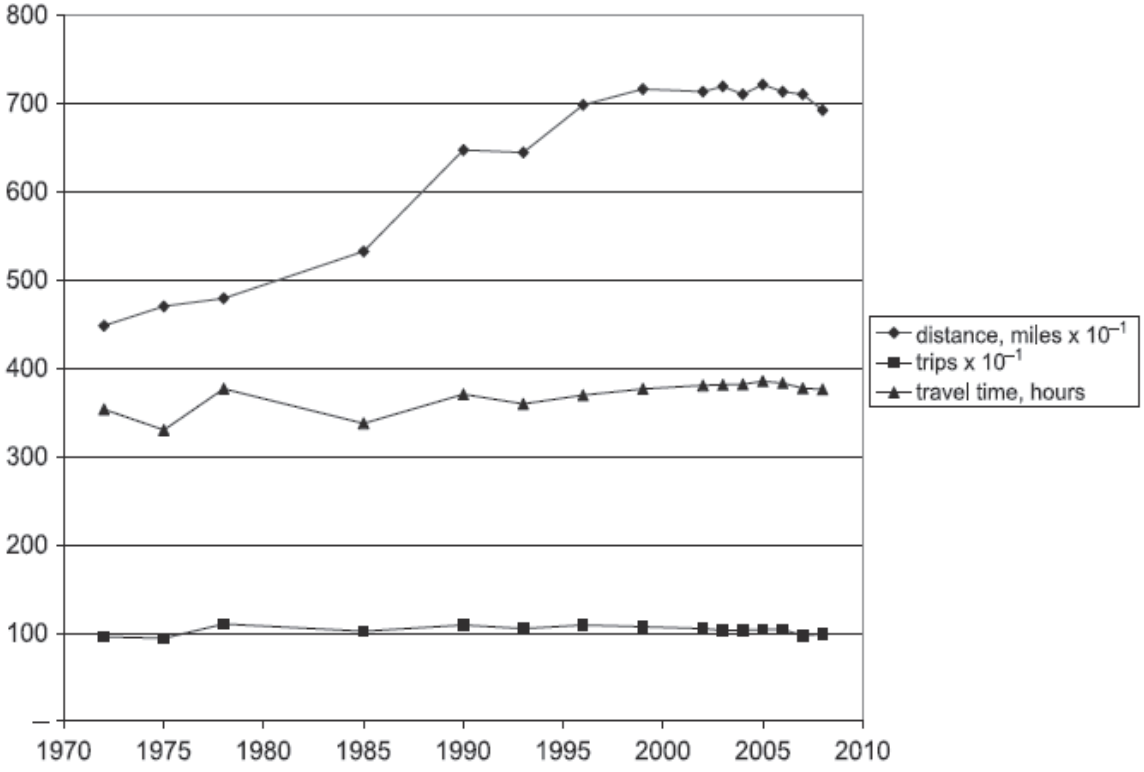


Source: Kuhnimohf *et al*. (2012).

For the United Kingdom, (Metz , 2010) observes that over the past 30 years the average travel time has remained stable at about 1 hour per day (375 hours per person per year), as has the average number of trips (1 000 trips per person per year). Car ownership has more than doubled, as have speeds, which in combination with rising income prompted a substantial increase in distances travelled, until a certain levelling-off as from the mid-1990s (Figure 3).

Metz puts forward a number of explanations for the levelling-off of traffic: fewer local trips due to longer absences from home (Madre and Armoogum, 1997), worsening congestion, fewer trips as a result of strides in telecommunications, and structural saturation of the demand for travel.

Figure 3. **Travel time (hours per person per year), distance (miles per person per year) in the UK**



Source: NTS 2008, Table 2.1 in Metz (2010), p. 661.

Do the trends being observed reflect the approach of the saturation point via a decoupling of the growth rates for traffic and income (Millard-Ball and Schipper, 2010)? Is this decoupling manifesting itself first in the most densely populated regions and/or over a certain standard of living? Or does the levelling-off of traffic result rather from a cancelling out of opposite trends (continued growth in rural and suburban areas and decline amongst residents of the most densely populated areas) (Goodwin, 2010-2011)? Some authors even posit the assumption of a reduction in travel in the developed countries in the short and medium terms, attributable to a variety of socio-economic factors (Litman, 2011). One could well ask whether this is a socio-demographic phenomenon (population ageing, re-densification of large centre-city areas, fewer but more-intensive workdays, with no returning home for lunch, etc.) or an economic one linked to rising and volatile fuel prices and the recession (Gardes *et al*., 1996; Collet, 2012).

The Mobility Research Task Force (ERA-MOB) of IFSTTAR's DEST laboratory has undertaken an analysis of the behavioural changes (Quételard, 2011) that are observed, for example, when people move house (Meissonier, 2011). Among other things, these changes are obviously a key consideration with regard to the outlook for energy and the environment.

2. The case of France

2.1 Observed trends

In France, since the mid-2000s the report on traffic conducted by the National Transport Accounts Commission has also shown a levelling-off of road traffic (CCTN, 2012): passenger car traffic has experienced no truly significant growth since 2003, *i.e.* not since petrol prices have been headed clearly upwards (SOeS, 2012). The sole example of steeper growth after 2003 than before is for buses and coaches, showing the vitality of collective transport. This reversal of the prior trend towards ever-greater mobility has been confirmed by household travel surveys (EMDs) in Lyon, Lille, Rouen, Reims, Rennes and Strasbourg, amongst others (Papon, Hivert, 2008; Quételard, 2011), and subsequently by the National Transport and Travel Survey (ENTD), which attributes this essentially to the inhabitants of major metropolitan areas (Hubert, 2009) and puts it back into an overall vision of mobility: travel by working people and students has become less frequent as uninterrupted work/school days have become the norm (Hubert *et al*., 2010), and the travel is less exclusively via cars. Consequently, rising fuel prices are probably not the only factor reversing the growth of individual mobility; alterations to the scheduling of activities (shorter working hours, teleworking, teleshopping, etc.) lessen the transport burden, making the reputedly most practical mode – the automobile – less indispensable for city-dwellers. Along with the decline of individual car traffic there has been a concomitant decline in the prevalence of household car ownership: this has been decreasing, even in the hearts of such major cities as London and Paris (STIF, 2012).

According to the national transport surveys, it is only in the 18 to 24 age bracket that a decline in the percentage of driving licence-holders has been observed – a decline that is especially pronounced in areas under urban influence (such as Île-de-France) (Table 1); the decline vanishes in the 25-35 bracket, but too much time elapsed between the 1993-94 and 2007-08 surveys to justify the assertion that there has been a catching-up, insofar as the cohort aged 18 to 24 in 1994 were between 32 and 38 in 2008 (Roux, 2012). Thanks to surveys less staggered over time, it can be noted that there was no catch-up in Lille, since the percentage of driving licence-holders aged 25 to 34 was also down in 2006, as compared with 1998. Elsewhere, as in the United Kingdom, the disinterest in driving licences has been attributed to the introduction of a theoretical test in mid-1996, even if a downturn has been observable since 1993 (Noble, 2005). In the United States as well, the decline in driving licences can be seen to coincide with a toughening of the tests administered in the various states (Davis *et al*., 2012).

Table 1. **Proportion of young adults holding driving licences by area of residence: Île-de-France (IdF), non-IdF, 1980s-2000s (as a %)**

Aged 18-24					
Date	**Mostly rural community non-IdF**	**Mostly urban community non-IdF**	**e.g. Lille**	**IdF**	**France as a whole**
1980s	75.7	59.9	58.7	59.7	62.3
1990s	69.5	69.6	64.5	56.8	66.9
2000s	78.6	67.8	54.0	48.7	65.7
Aged 25-34					
Date	**Mostly rural community non-IdF**	**Mostly urban community non-IdF**	**e.g. Lille**	**IdF**	**France as a whole**
1980s	87.8	81.2	81.9	78.2	81.9
1990s	91.7	87.6	85.7	78.9	86.7
2000s	95.8	88.3	80.1	81.6	88.5

Sources: National Transport Surveys (ENTs) for 1981, 1993 and 2007; Household Travel Surveys (EMDs) for Lille for 1987, 1998 and 2006.

2.2 Long-term outlook

The slowdown in individual car use and ownership raises the question of their future trajectories. Three scenarios are theoretically feasible (Goodwin, 2010-2011; Collet *et al*., 2012):

1) Resumed growth after the current pause;
2) Saturation at levels to be specified; or
3) A reversal of the trend after peaking to a plateau, to be specified as well.

What frameworks need to be formulated in order to formalise these trends and analyse them in respect of different categories of the population and modes used?

Any assumption that car ownership and individual car use could grow indefinitely over time would seem far removed from practical reality. Consequently, if there is an upswing in the years to come, the saturation point will ultimately be reached thereafter, to be followed by a possible decline. Assuming that the recently observed slowdowns are in fact a harbinger of peak car use, we propose to determine the levels involved on the basis of the French case. We therefore excluded the first hypothesis, but we shall make no judgement as to whether peak car use is permanent or not. In other words, we shall not discriminate between scenarios two and three, depending on whether the peak corresponds to a long-term saturation or a maximum preceding a downturn.

Despite one of Europe's highest fertility rates, the demographic profile in France is one of low population growth and a certain degree of ageing. In the European territory of France, the growth forecast is for 0.38% per year between 2010 and 2030. In addition, the proportion of the population aged 65 or over rose from 11.4% in 1952 to 13.9% in 2000 and 16.7% in 2010 and is expected to reach 23.2% in 2030 and 26.2% in 2050 (INSEE projections).

Against this background, how does the levelling-off of car traffic since the 2000s, especially in the most heavily urbanised areas, tie in with the long-term trend towards the spread of automobiles from the well-to-do to modest segments of the population? We shall describe this process from 1974 until 2010, in France as a whole and in Île-de-France, making a distinction between four quartiles of household living standards. At each date, average households of the income distribution quartiles by unit of consumption are called Q1 to Q4, from the most modest to the most well-to-do. Going back to around the first oil shock, we have access to comparable annual surveys: INSEE monthly consumer confidence surveys (ECAMs) until 1994 and the car fleet (Parc-Auto) panel thereafter. Because these panels re-question the same households at least two years running, it is possible to detect changes in behaviour and to improve accuracy significantly when estimating time series.

In order to situate car peak levels, our approach is based on aggregated time series, focusing attention on segments of the population likely to exhibit pioneering behaviour: the most well-to-do households (less held back by financial constraints) and residents of the Île-de-France (who had cars before provincials but are constrained by density and served by a good public transport network). Saturation, represented graphically by a sigmoid curve, appears as an intermediate hypothesis between a resumption of growth and decline; moreover, linking the level of the distance-travelled asymptote to fuel prices could explain the observed reversal of the trend.

Second cars have succeeded first ones as the vector of increased car ownership

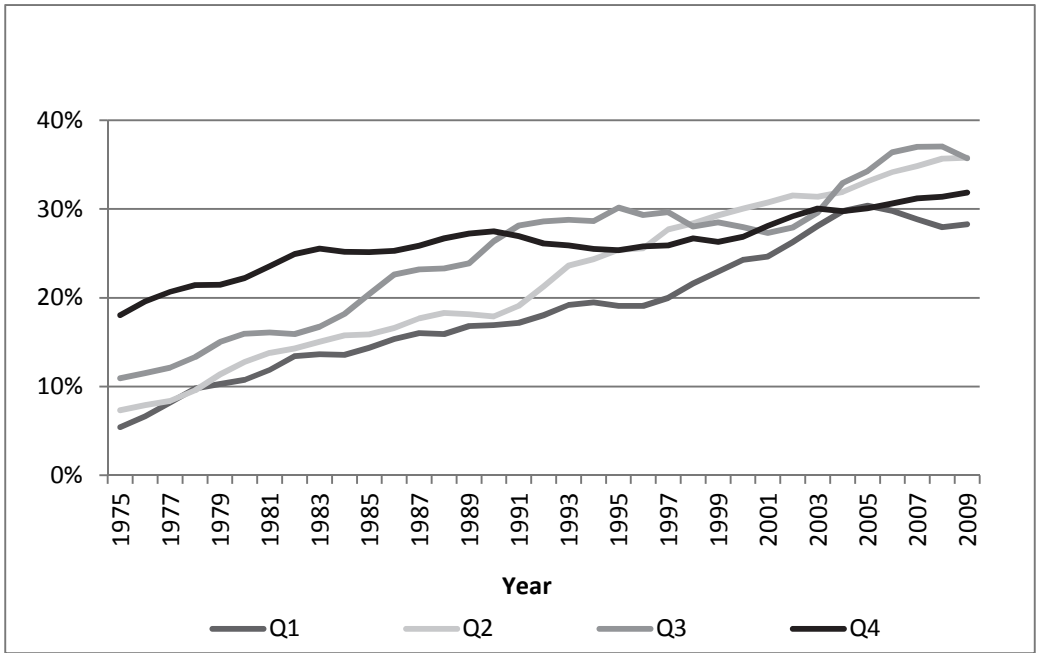
In France as a whole, the rate of car ownership amongst modest households has practically caught up with that of the most well-to-do: the proportion of carless first-quartile households dropped from 55% in the mid-1970s to 35% in the mid-90s.

It is second cars that have constituted the primary vector in reducing car ownership inequalities. Multiple ownership in fact tended to rise with living standards until 1990. Subsequently, Q2 and Q3 grew close together and exceeded Q4, since the most affluent households tend to live in densely populated areas, and particularly in the Île-de-France (Figure 4).

Insofar as multiple car ownership no longer shows significant differentials, depending on living standards, the social distribution of cars has reached its limits. In the Île-de-France, inequalities stopped declining in the early 1980s, and then the trend reversed in the latter half of the 90s, with inequalities of car ownership now slightly more pronounced than in France as a whole.

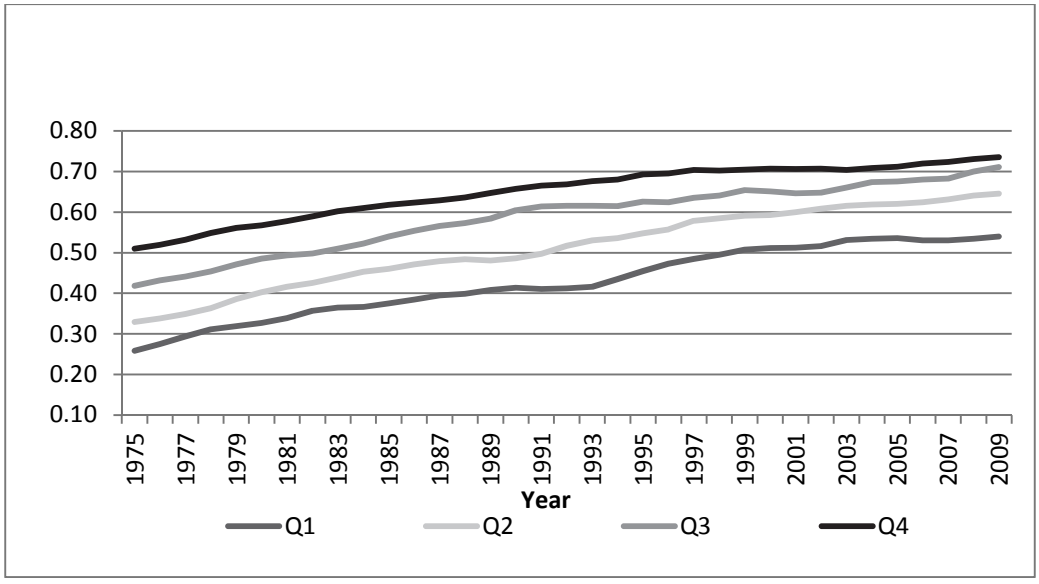
Nationally, curves tracing the average number of cars per adult slope upward and are concave, whatever the standard of living (Figure 5); the hierarchy of car ownership levels is consistent with living standards throughout the period under study. The same holds true in the Île-de-France (Figure 6), with the Q1 curve levelling off after having practically caught up with Q2 around the early 80s and car ownership among the most affluent households remaining flat since the mid-90s.

Figure 4. **Trend in household multiple car ownership in each income quartile, by consumption unit, France as a whole**



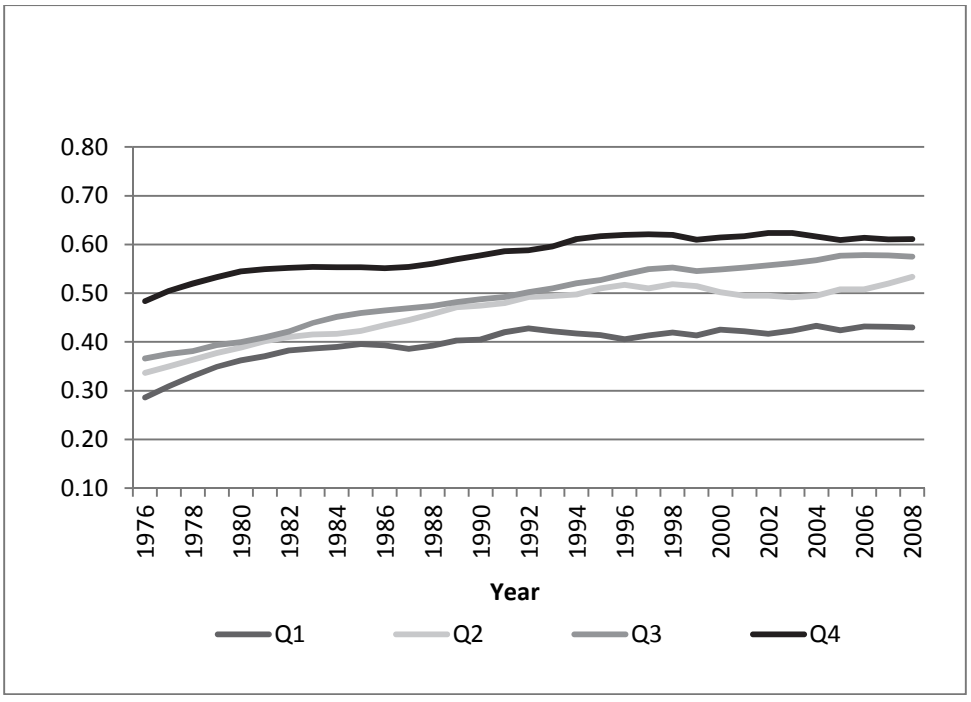
Source: DEST-IFSTTAR – ma3 = moving average over three years.

Figure 5. **Trend in the average number of cars per adult in each income quartile, by consumption unit, France as a whole**



Source: DEST-IFSTTAR – ma3 = moving average over three years.

Figure 6. **Trend in the average number of cars per adult in each income quartile, by consumption unit, Île-de-France**



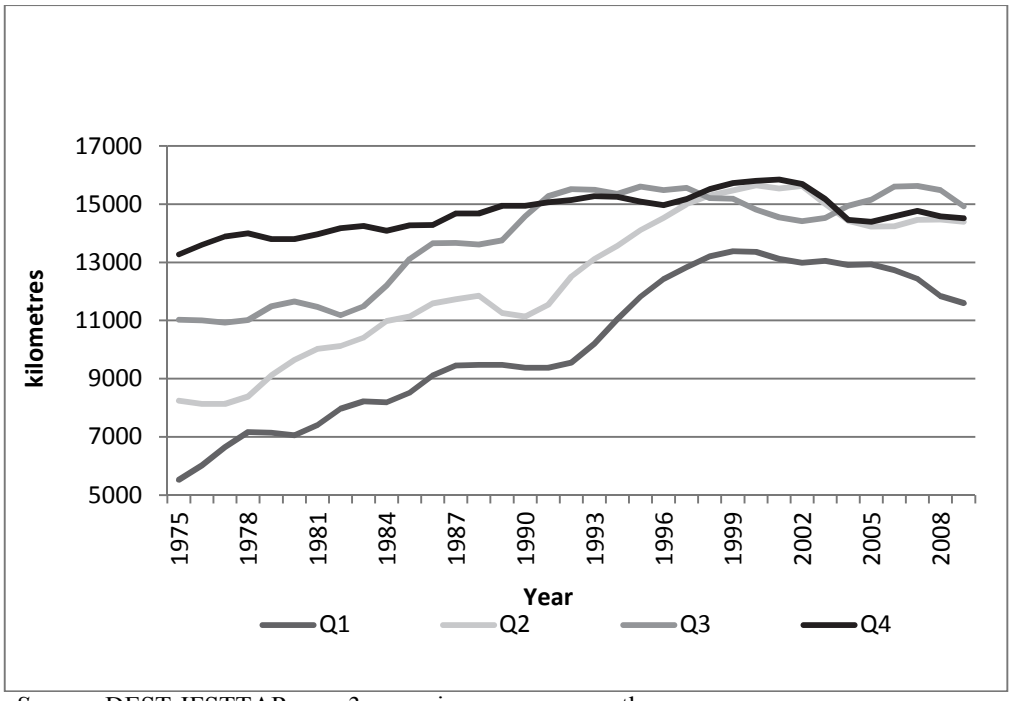
Source : DEST-IFSTTAR – ma5 = moving average over five years.

The spread of car use modulated by fuel price fluctuations

After the two oil shocks of the 1970s and a levelling-off in the first half of the 80s, the cost of car use declined – first because of the 1985-86 counter-shock, and then because of the rising proportion of diesel-powered cars due to lower taxes on diesel fuel. On the whole, the average distance driven by households increased until 2000 (Figure 7), and then, since car ownership did not decline, decreased because of the average distance driven per car, which stemmed from rising fuel prices. After peaking in 2000, fuel prices rose continuously from 2004 until mid-2008 and then fluctuated widely, setting a new record in the spring of 2012. The curves corresponding to Q1, Q2 and Q4 followed the same general pattern; that of Q3 peaked in the 1990s.

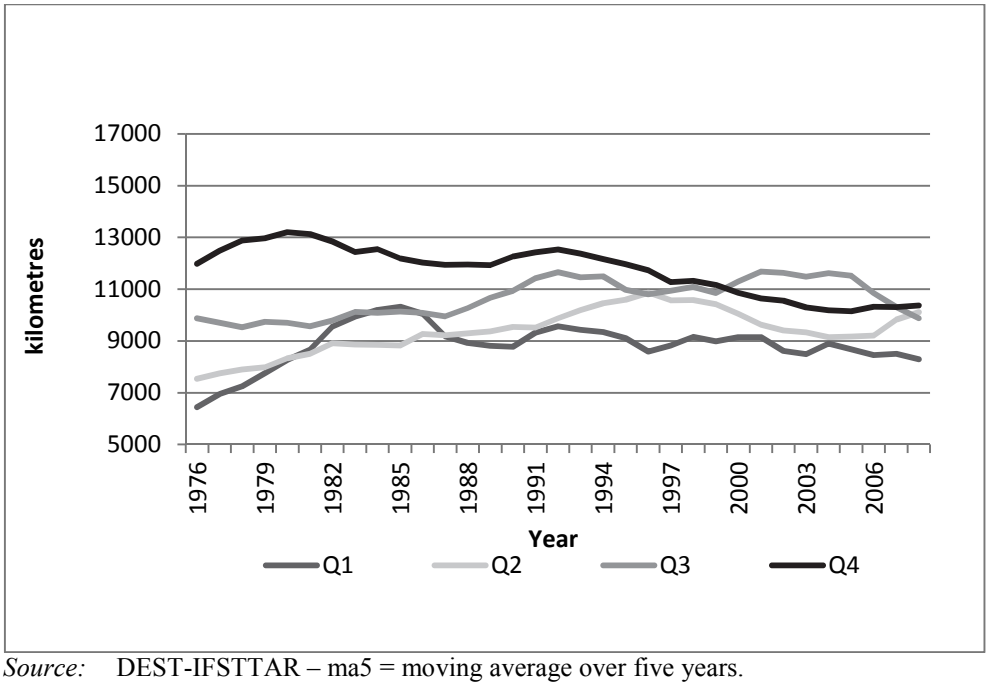
The decrease in distance travelled is more distinct for inhabitants of large cities than for people living in less densely populated areas. For people living in Île-de-France, for example, the levelling-off began in the early 1980s for Q4, and in the first half of the 90s for Q3, and in the latter half of the 90s, and thus before the 1999-2000 peak, for Q2 (Figure 8). Q2, Q3 and Q4 seem to converge at the end of the period, whereas Q1 stands apart. When fuel prices rise, it is harder for the poorest households than it is for others to reduce their already-low car use if they do not have public-transport alternatives.

Figure 7. **Trend in average annual distance travelled per household in each income quartile, by consumption unit, France as a whole**



Source: DEST-IFSTTAR – ma3 = moving average over three years.

Figure 8. **Trend in average annual distance travelled per household in each income quartile, by consumption unit, Île-de-France**



Source: DEST-IFSTTAR – ma5 = moving average over five years.

Finally, after a period of status quo between the mid-1980s and the mid-90s, the social distribution of car ownership picked up again as it had in the 1970s, especially in the least densely populated areas, where dependency on automobiles is greater, for lower income households in particular (Dupuy, 1999).

What are the limits on the growth of car ownership and car use?

Theoretically, the social distribution of an asset over time can be represented by a sigmoidal curve tending towards an asymptote – the level of saturation. If it is assumed that the car-related behaviours dealt with here follow this pattern, which is consistent with the levelling-off of traffic observed in the 2000s, our data collected since the mid-1970s essentially cover the upper portion of the sigmoid. We adjusted the Chapman-Richards model (Richards, 1979) separately for each quartile, and then for all households.

With respect to car ownership in France as a whole (Table 2), the inflection dates are staggered from 1961 for Q4 to 1972 for Q1: they are therefore well prior to the beginning of our observations and suggest that car ownership trends are differentiated by quartile. In contrast, the saturation thresholds do not differ significantly: accordingly, in estimating the car ownership model we constrained it by a car ownership ceiling common to all quartiles. The estimate was fairly precise, its 95% confidence interval being (0.74; 0.78) car per adult.

Table 2**. Sigmoid curves adjusted to the average number of cars per adult, France as a whole**

Model: Chapman-Richards (defined on 1920; +inf)
Constraint (S and b4 common to all quartiles)
$R^2 = 0.99959$

Y	Coefficient	Std. dev	Student	P>t	(95% Conf.	Interval)	Year of inflection
S	0.7618565	0.009165	83.18	0	0.7437356	0.7799774	
Quartile 1							
b1	0.0328789	0.0011699	28.11	0	0.0305659	0.0351919	1973
b3	0.825462	0.0128132	64.42	0	0.800128	0.850796	
Quartile 2							
b1	0.0461801	0.0018558	24.88	0	0.0425109	0.0498494	1970
b3	0.9015596	0.0103673	86.96	0	0.8810616	0.9220575	
Quartile 3							
b1	0.0552784	0.0030402	18.18	0	0.0492673	0.0612895	1965
b3	0.9188615	0.0134812	68.16	0	0.8922069	0.9455161	
Quartile 4							
b1	0.0654347	0.0055028	11.89	0	0.0545548	0.0763147	1961
b3	0.9312386	0.020351	45.76	0	0.891001	0.9714762	

Sources: ECAMs 1974-94, Parc-Auto 1994-2010.

In the Île-de-France, the ceilings on ownership rates depend to a significant extent on household living standards: the 95% confidence interval for the most modest quartile is (0.41; 0.43) car per adult, (0.52; 0.57) for the second quartile, and (0.59; 0.69) for the third. However, no significant difference is observed between the third quartile and the fourth, most well-to-do, quartile, for which the ownership

rate ceiling is estimated at between 0.61 and 0.65 car per adult. Because of the high population density in greater Paris, estimated car ownership rates in Île-de-France are all significantly lower than those previously calculated for France as a whole (0.76 car per adult).

For annual distances travelled per household, the lower the household standard of living, the more recent the inflection dates, which are staggered between 1952 and 1974 (Table 3).

This assumption being acceptable on the face of the data, we estimate a model constrained by a common ceiling S_2 and a common elasticity of fi. The usage ceiling at 2010 fuel prices was then estimated at 16 200 km/year. It was thus calculated that the usage ceiling per household in France would drop by roughly 2 400 km if fuel prices doubled relative to their 2010 level, falling to 13 800 km/year.

Table 3. **Sigmoid curves adjusted to the average annual distance travelled by household as a function of fuel prices, France as a whole**

Model: Chapman-Richards (defined on 1920; +inf) Constraint (S and b4 common to all quartiles) $R^2 = 0.99704$							
Y	**Coefficient**	**Std. dev**	**Student**	**P>t**	**(95% Conf.**	**Interval)**	**Year of inflection**
S	16305.55	723.0406	22.5	0	14875.88	17735.22	
b4	-0.2375254	0.0515408	-4.61	0	-0.3394373	-0.1356135	
Quartile 1							
b1	0.046344	0.0053069	8.73	0	0.035851	0.0568379	1976
b3	0.926301	0.021461	43.16	0	0.8838661	0.968736	
Quartile 2							
b1	0.0610387	0.0102628	5.95	0	0.0407459	0.0813314	1971
b3	0.9560175	0.024079	39.7	0	0.308406	1.003629	
Quartile 3							
b1	0.0575344	0.0144213	3.99	0	0.0290192	0.0860496	1963
b3	0.9138604	0.0647738	14.11	0	0.785783	1.041938	
Quartile 4							
b1	0.025962	0.0110172	2.36	0.02	0.0041778	0.0477463	No inflection
b3	-0.115645	0.6507985	-0.18	0.859	-1.402471	1.171181	

Sources: ECAMs 1974-94, Parc-Auto 1994-2010.

In Greater Paris, and in contrast to the results for France as a whole, the usage ceilings are estimated fairly precisely for each quartile of living standards. At a relative fuel price equivalent to that of 2010, the distance driven by the most modest quartile of Île-de-France residents should peak to around 8 600 km/year, 10 000 for the second quartile and 10 700 for highest two quartiles. The confidence intervals for these estimates are relatively narrow and would suggest significant differences amongst the first three quartiles. Elasticity to fuel prices does not differ significantly from one quartile to another; the constrained model estimates it at -0.31.

By adjusting the sigmoid curves, the saturation points can be situated at approximately 0.76 car per adult and 16 400 km per year and per household; this distance-driven ceiling is modulated by an elasticity of -0.24, reflecting reactions to erratic fuel price movements. In the Île-de-France, however,

where traffic congestion is heavy and the network of public transit well developed, the distances driven peaked earliest for the most well-to-do households, before the rising fuel prices of the 2000s, suggesting the onset of a major trend of which Île-de-France residents were precursors.

Behavioural changes or structural effect? A demographic approach

Since the mid-20th century, car use in cities, as elsewhere, expanded continually at a sustained and regular pace, and no slowdown in the growth was perceptible. But starting in 2006, all of the household travel surveys started to show a levelling-off and, in many cases, a decline in car use, only a small portion of which can be explained by the shifting structure of the population (and ageing in particular) (Quételard, 2011):

- In Lille, trends in the structure of the population should have brought about a slight growth in mobility (4.02 trips per person and per day in 2006, versus 4.00 in 1998), yet the observed average was 3.76.
- In Lyon, structural trends should indeed have brought about a drop in mobility, but the observed drop was much greater, from 3.63 in 1995 to 3.36 in 2006 (3.60 at constant structure).
- In Strasbourg, 10% of the drop in mobility of Urban Community residents was linked exclusively to population ageing, and the increase in the proportion of workers and students working or studying on an unbroken-day basis mechanically explains 20% of the drop in mobility (ADEUS, 2010).

Are these behavioural changes linked to the economic situation or to structural effects? To try to answer this question, we analysed the case of the Urban Community of Lille, where household travel surveys were carried out in 1987, 1998 and 2006, adjusting a demographic Age-Cohort projection model so as to isolate structural age and generational effects arising from the life cycle.

For Lille, we applied the Age-Cohort model (described in Bussière, Madre and Armoogum, 1996) to a variety of mobility variables for the period 2000-2030. One initial conclusion is that because people travel less above a certain age, population ageing has a definite impact, but this is only a partial explanation for the levelling-off of mobility observed in the 2000s. Population ageing, which reduces the weighting of young people, amplifies the levelling-off phenomenon.

Calibrating the model requires at least two years of observations with a fairly distant interval between them. From the three survey years available (1987, 1998 and 2006) we successively calibrated the model with all three years, with 1987 to 1998, and with 1998 to 2006. Each of the three estimations yield very different results, since the levelling-off of mobility was noted only at the time of the last survey. The more recent the calibration data, the higher the levelling-off point. Based on the two last calibrations, we obtained the following results. Projecting forward to 2030, the proportion of adults holding driving licences should remain flat, as should the distance travelled per person in an individual car as either driver (Figure 9) or passenger, with a significant increase in the distance travelled per day per person in public transport (Figure 10). For example, beyond the renaissance of public transport observed in 2000, the model shows that its use could grow by more than 15% between 2000 and 2030, based on the 1987-1998 setting, and by 47% if the model is calibrated on the two most recent surveys. The significant differences observed between behaviours that prevailed until the 1990s and in the 2000s in fact explain the reversal of the tendency observed and lead to highly divergent projections, which for a long-term perspective once again raise the question of whether the recent trends are structural or cyclical.

Figure 9. **Age-cohort model simulation, Lille, 2000-2030.**
Average distance travelled per day per person in kilometres, car drivers

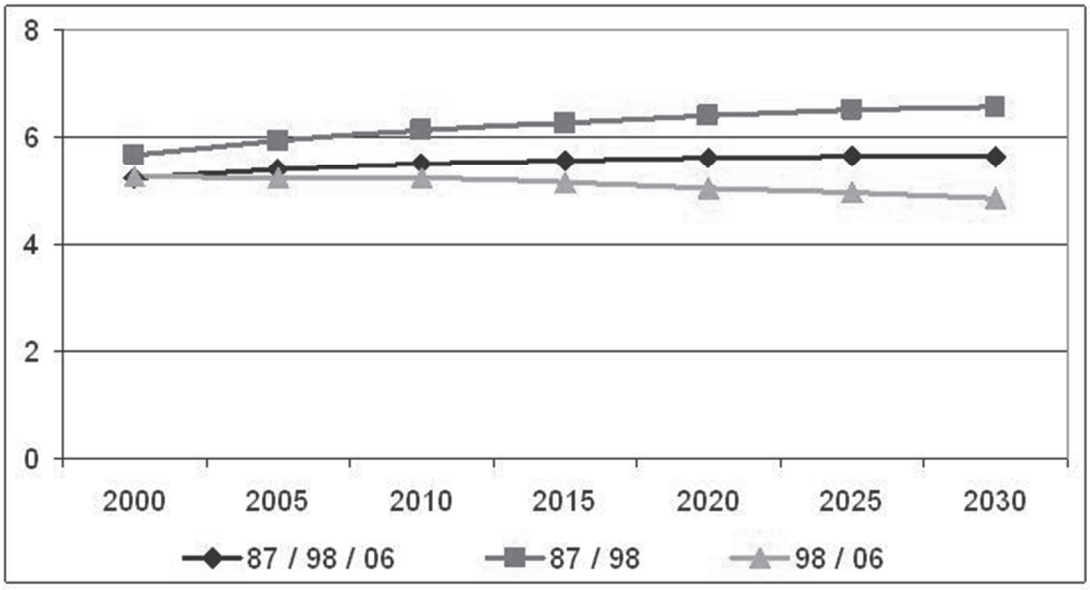
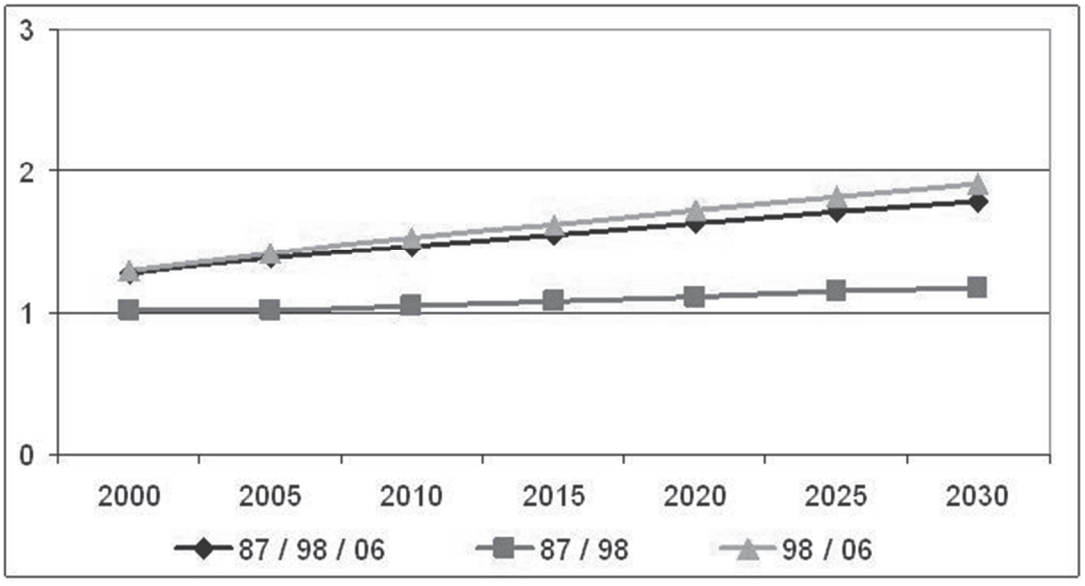


Figure 10. **Age-Cohort model simulation, Lille 2000-2030,**
Average distance travelled per day in kilometres, public transport



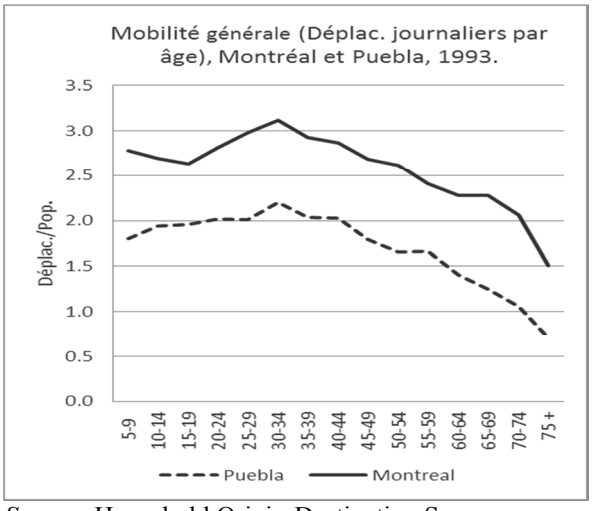
The ageing factor in developed countries versus emerging economies – the example of Mexico

An initial simple approach for measuring the impact on mobility of the shifting age pyramid is to apply sustainable transport behaviours to an age pyramid that is shifting over the long term. Here we shall show such a shift, using a comparison between Montreal and Puebla. The linkages between age or life cycle, mobility and modal choice are well established and relatively stable over time. As can be observed in the figures below, general mobility is bell-shaped. In Montreal, in 1993, it peaked at around age 35, and declines regularly thereafter until advanced ages. In Puebla, for the same year (1993-94), a virtually identical curve can be observed, but with a lower overall level of mobility. With regard to modal choice, car driver mobility is bell-shaped, peaking in Montreal at about age 40. The form of the curve in Puebla is similar, peaking somewhat later, at about age 45 albeit at a lower level. Public transport being in direct competition with cars, the observed curve is U-shaped in the case of Montreal and adopts a similar form in the case of Puebla (see Figures 11 to 13). The combined result of these trends will inevitably yield high individual car use in active age groups, translating into car/km such as can be noted in the United States for the period 1995-2001-2009, where a decrease in car/km can be seen in respect of the youngest drivers, but an increase for the over-65 age groups (Figure 14).

In the absence of survey data spanning a long period, we have assumed stable mobility behaviours and applied those behaviours by five-year age brackets over a long period using the cases of Montreal and Puebla. In Montreal's case, we rediscovered an exercise that we had done 22 years ago, but which at the time had left transport engineers sceptical. We projected 1982 behaviours over a 40-year time span (1971-2011), Figure 15 (Bussière, 1993). For lack of detailed demographic data over a long series for the city of Puebla, we redid the same exercise using population data from Mexico, projecting Puebla's 1993-94 behaviour over a 100-year period (1950-2050) (Figure 16). To validate the methodology we did another simulation on 2000-2050 demographic data, which yielded similar results.

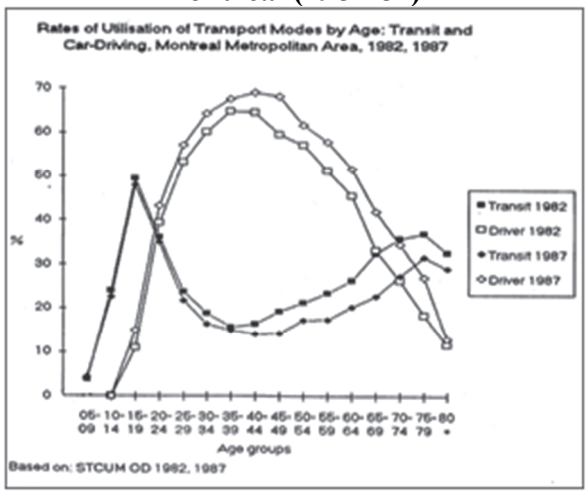
What conclusions can be drawn? These simulations are obviously not projections of past and future demand because they do not factor in behavioural changes related to lifestyles and urban contours. They do, however, make it possible to isolate the demographic factor. In the case of Montreal, where the baby boom had been very substantial and followed by a sharp drop in birth rates, from the 1970s until the late 90s there was an exponential increase in pressures towards individual car ownership and a decline in public transport, with individual car ownership reaching an inflection point in 2001, followed by a decline. This was exactly the same trend as was observed in the great majority of developed cities (Figure 1). Without prejudice to other factors (urban contours, access to cars, lifestyle), it can therefore be concluded that the demographic impact on trends in individual car ownership is substantial, and that we are currently witnessing a saturation effect in respect of that impact.

Figure 11. **Overall mobility by age, Montreal and Puebla (1993) (Trips per day by age) Trips/Pop.**



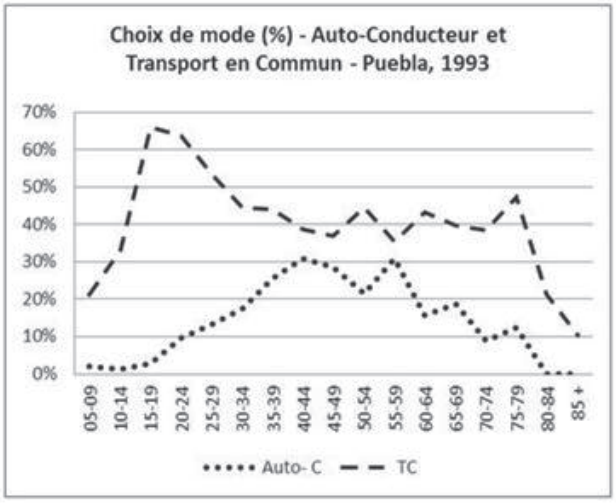
Source: Household Origin-Destination Surveys.

Figure 12. **Modal choice by age of car-driver and Public Transport (PT), Montreal (1982-87)**



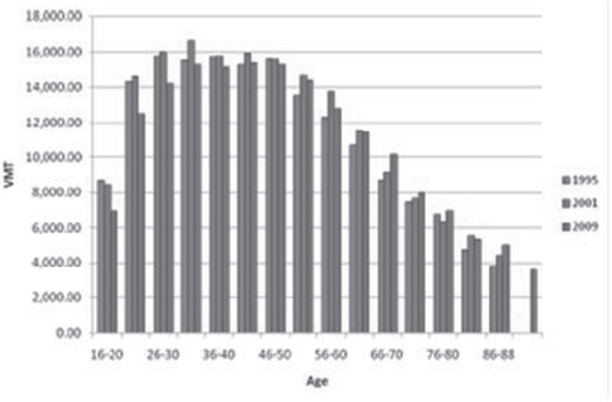
Source: Household Origin-Destination Surveys.

Figure 13. **Modal choice by age - Car-driver and public transport (PT), Puebla (1993)**



Source: Household Origin-Destination Surveys.

Figure 14. **Annual vehicle-miles per driver by age, USA, 1995, 2001, 2009**



Source: OECD/ITF (2011), p. 29

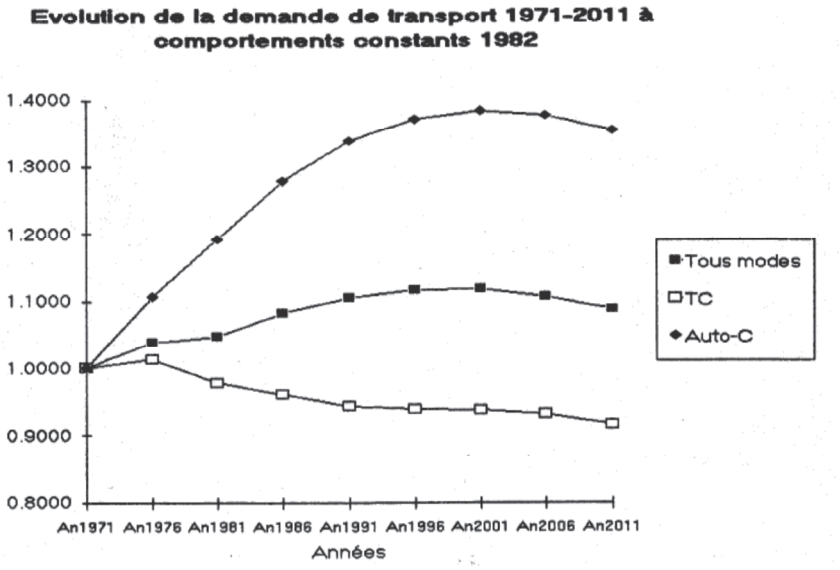
In emerging economies, populations are still young, but the ageing phenomenon will arrive there as well. In Mexico, population growth, which had been very rapid until recently (averaging 1.58% per year between 1990 and 2010) can be expected to slow. The annual growth rate should average roughly 0.67% between 2010 and 2030, with rapid and substantial ageing (the proportion of people aged 65 or over was 3.4% in 1950, 4.2% in 1990, 6.4% in 2010 and is forecast to be 12.5% in 2030 and 22.0% in 2050), according to CONAPO projections. In the cities, growth should be slightly more rapid because of a continuing rural exodus. A simulation on greater Puebla shows the beginnings of demographic pressures conducive to individual car ownership around the year 2000, at the same time that a slowdown was being observed in developed cities. There ensued some three decades of heavy demographic pressure conducive to individual car ownership and a slowdown in public transit. The

inflection point is to come at around 2035, after which there will be a slowdown in individual driving and a virtual levelling-off for public transport. What conclusions can be drawn from this? This simulation represents a minimalist scenario because it assumes a continued low level of car ownership. If the growth in living standards and household car ownership factor is added in, the result would be explosive for at least another 20 years. A recent household origin destination transport survey in Puebla (2011) gives us interesting input with which to complete the picture. Between 1994 and 2011, per capita mobility remained stable (at 1.75 trip per day per person), as did individual car ownership, which followed population growth (up 50%), but persistent poverty did not allow household car ownership to increase. On the contrary, the proportion of households with cars fell to 33% in 2011, as compared to 39% in 1994, and the proportion of households with more than one car was only 3.8% in 2011 versus 10.3% in 1994. To a large extent, this trend reflects the persistence of poverty. While in 1994 19.0% of households suffered from food poverty, the rate did not change in 2008, with 19.5% (Figure 17) (Coneval, 2009). In addition, over the same period, the average age of cars on the road increased from 9.4 to 13.0 years. A 2012 survey in the city of Colima on the west coast of Mexico indicated an average age of household cars of 13 years. In France, there has been an ageing of the cars on the road, the average age of which increased from 6.2 years in 1993 to 8.2 years in 2007 (Kolli, 2012), but for quite different reasons: the greater number of second cars, which are driven less and last for longer.

To round out this initial analysis with a more complex methodology that incorporates a greater number of factors, we applied the Age-Cohort model to two Mexican cities for all travel. For Puebla over the period 1996 to 2030, based on 1994 and 2011 surveys (Figure 18); and for Ciudad Juárez over the period 1996 to 2030, using 1996 and 2006 surveys (Figure 19). In contrast to our initial purely demographic simulations, these simulations factor in behavioural changes by closely defined age groups, which indirectly incorporate a series of factors such as changing urban contours, income and lifestyle. In the case of Puebla, an inflection point is obtained in 2020, with subsequent decline. In the case of Ciudad Juárez, based on a slower demographic growth scenario given the current context of violence (projected average annual growth rates of 1.60% from 2006 to 2012 and 1.06% from 2015 to 2030), the inflection point appears earlier, in 2015, which could not be explained by population ageing, since only 5.4% will be aged 65 or over in 2015, but probably by a beginning of saturation of individual car ownership, with 72% of households having cars, as compared with 84% in France in 2007-08, and 36.4% of households having more than one car, as compared to 38% in France in 2008 (Kolli, 2012). Here, too, the average vehicle age is increasing, rising from 11.7 years in 1996 to 13.8 in 2006, due possibly to multiple ownership, the persistence of relative poverty and the proximity of the US border, which facilitates lightly-taxed imports of vehicles aged ten years or more.

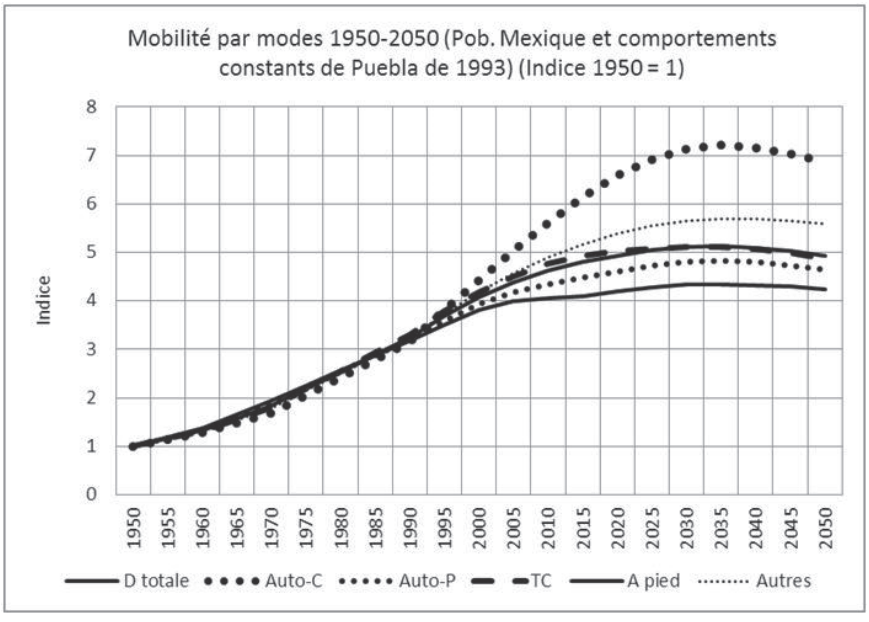
Figure 15. **Transport demand trends (All modes, public transport, car-driver) Montreal, 1971-2011 (1971=1)**

At constant 1982 behaviour



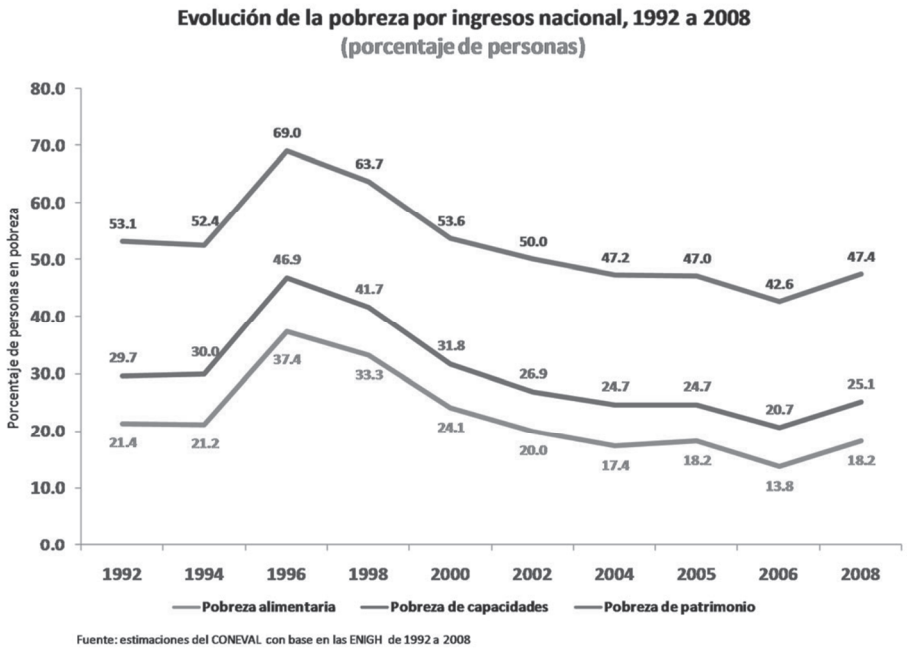
Source: Bussière and Fortin, 1990, based on *Traitements INRS*, 1971-2011.

Figure 16. **Estimated mobility by mode, Puebla metropolitan area, 1950-2050**



Source: Bussière, October 1991.

Figure 17. **Poverty trends (food, capacities, wealth) Mexico, 1992-2008**



Source: Coneval (2009).

Figure 18. **Simulation on Puebla – Distance in km per person, all modes combined – 1994-2030**

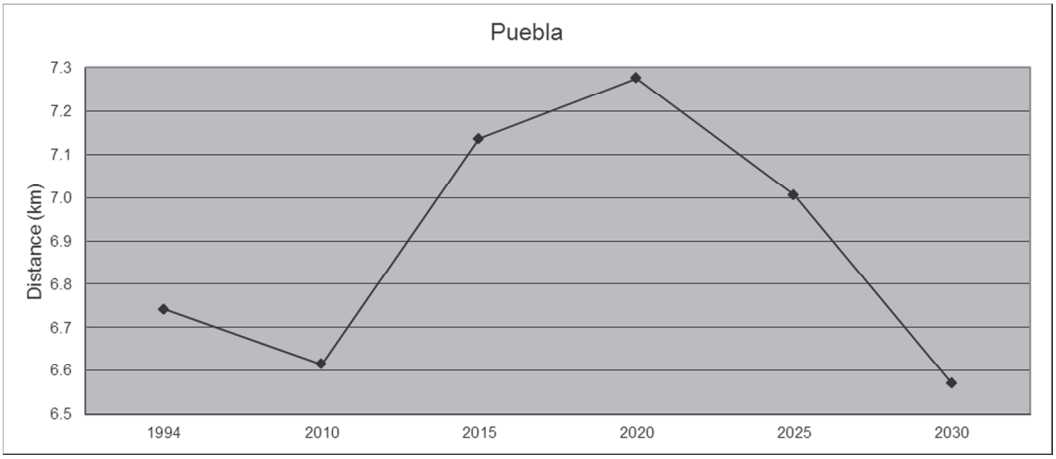
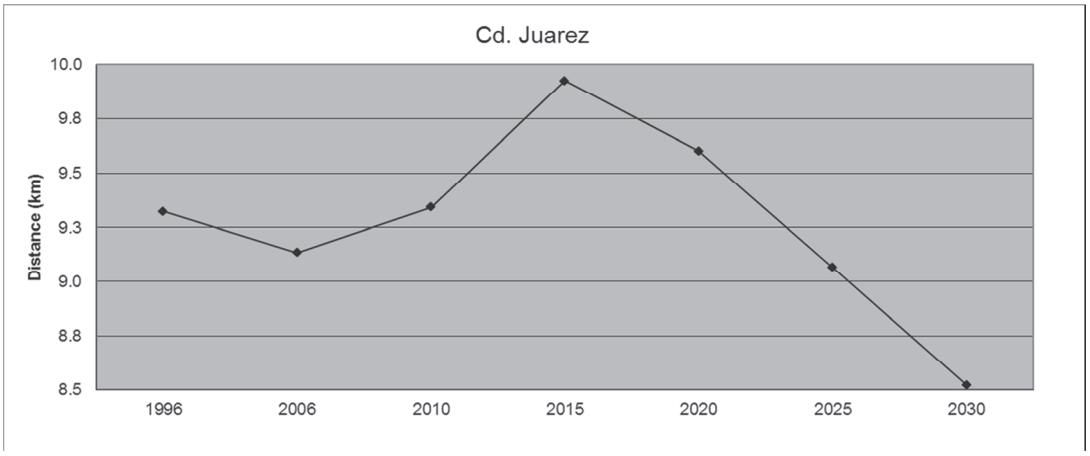


Figure 19. **Simulation on Ciudad Juarez – Distance in km per person, all modes combined – 1996-2030**



3. Conclusion

To summarise with respect to France, the main findings are as follows: the same trend towards a decline in mobility can be found here as in most other developed countries, starting in the early 2000s, whilst the average distance travelled by households was levelling off and dropped slightly thereafter, with cyclical variations probably linked to: fuel price variations; a drop in the percentage of young people holding driving licences in the most densely populated urban areas (elsewhere, the opposite can be seen); the social distribution of car ownership, which is attaining its limits, with the decline in inequalities of automobile ownership and the widespread increase in second cars; an ageing of the cars on the road; a saturation of car ownership in Île-de-France and a slowdown outside the region. In addition, there can be seen significant growth in the use of public transport.

In our case studies in Mexico, we can also make out a saturation phenomenon that could take place in roughly 20 years in the most traditional cities and slightly earlier in more developed cities, provided there is a slowdown in population growth. The car population is old, however, and is not tending to get any younger; for lack of purchasing power, but also due to policies that encourage ownership of old vehicles, such as the annual vehicle tax from which cars aged 10 years or older are exempt – a tax that was recently abolished at the national level (federal tax) and in certain states (Puebla and Tlaxcala in 2011).

Given the finding that overall mobility as well as urban car mobility has reached a saturation point, or at the very least has been slowing in the developed countries, along with the probable appearance of a similar tendency in emerging economies, but only in about 20 years after intense pressure for individual car ownership, what can be concluded in policy terms?

With respect to developed countries, in which the growth of cities is changing, there is an encouraging sign that it will be easier to shift the focus of urban transport planning: restrict car usage

in the city, while promoting the use of public transport and soft modes; control urban extension by making suburbs denser and bolstering public transport systems; rethink the construction of toll roads at the periphery of metropolitan areas, which are perhaps no longer useful nor worthwhile economically; rethink our conception of quality-of-life in the city, with less emphasis on the fluidity of car travel; introduce various measures to manage demand in order to diminish the number of trips and car travel within cities. It would also be necessary to address the technology by imposing stricter standards on manufacturers. Nevertheless, the impact on the production cycle and the renewal of cars on the road could take another two decades. The transition must therefore be accelerated (Schipper, 2011).

With respect to emerging economies, despite the great disparities from one country to another, and from one city to another, the example of Puebla and Ciudad Juárez can give us an idea of the magnitude of the challenge to be taken up in the years ahead:

- Population growth will remain relatively strong for at least another one or two generations;
- It is likely that cities will expand in a way that is disordered and staggered;
- Socio-economic equality between households in terms of car ownership is only beginning;
- The great majority of transport policies favour the use of automobiles, along the lines of the US model from the 1970s, at least in Mexico and elsewhere in Latin America;
- Most public transport is fairly rudimentary and not very competitive in relation to travel by car, and the absence of redistributive taxation makes it difficult, except in very large cities, to modernise it and introduce operating subsidies to make it more competitive;
- The public's lack of awareness of environmental issues;
- Security problems are complicating the introduction of non-motorised modes, which cities in the north are adopting more and more.

What, therefore, would be the most appropriate policies?

First, existing facilities must be strengthened. Many Mexican and Latin American cities built on the European model still have high population densities comparable to European cities. Policies should be crafted to maintain the density of city centres and avoid constructing ring roads without companion measures to avoid population flight from the centre to the periphery; modernising public transport to make it more competitive relative to cars and to change its image from a mode of transport for poor people to a mode of transport for everyone; to foster the introduction of pedestrian areas in city centres and in suburbs; foster continued use of bicycles in many cities where it has not yet disappeared; promote expansion of bicycle use for utilitarian and recreational purposes; regulate the fleet of cars to make it younger, with cleaner vehicles; disseminate information and facilitate procedures to have access to carbon vouchers that could finance these measures.

Yes, the trend towards ever-greater urban mobility, which seems to be reversing in the developing countries, can be expected to spread to a number of emerging economies, but only in a couple of decades. The challenges for sustainable transport are as great as ever.

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Chapter 2

Peak Travel, Peak Car and the Future of Mobility:
Evidence, unresolved issues, policy implications and a research agenda

Phil Goodwin[3]

Abstract

In many advanced economies, car use per head, and sometimes total car traffic, has shown low growth. In some countries (and especially cities) it has declined. In a few countries, there have been similar studies of the distance travelled by all modes added together, which has shown a similar trend though with some doubts about how international air travel should be handled. It is generally agreed that the trends in the last few years must be influenced by world economic problems, but some of the possible changes in trends seem to go back ten or twenty years, with signs detectable even further back.

Although there are differences of emphasis, the statistical facts of a reduction in historic growth, low growth or stability at national level, and reductions in specific locations, especially some larger urban areas, seem broadly agreed by most analyses. This evidence is sometimes ignored, but it is not contested.

There is great interest in the appearance of some common features in many countries, notably including changes in the propensity to get driving licences among young adults (especially teenage men), an apparent weakening of the association between income and mobility, a greater influence of public transport, walking and cycling to economic prosperity in some of the most successful cities, and the development of e-commerce, telecommuting and social networks.

There are currently differences in judgement on how influential these factors are, and on whether the observed trends are temporary or reflect structural shifts which could be long-lived. These differences especially focus on the relative importance of economic issues (particularly prices and incomes) and wider social and cultural changes, such as mobile internet access, demographic, gender, attitudinal and cultural trends, the effects of transport policies and the possibilities of deeper concepts of "saturation" of mobility when further increases bring little extra benefit. There is at the moment no strongly-established common view about future growth in car use to the extent that was taken for granted in earlier decades.

The paper discusses research needs, and some emerging issues for future transport policies, including the appraisal of large-scale transport infrastructure projects, service provision, pricing, the allocation of risk and initiatives to reduce car dependence, in the context where forecasts are problematic and contested.

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1. Introduction

This paper seeks to summarise the current state of play of discussion about reduced traffic growth in recent years. In a wide variety of different studies, using different methodologies and definitions, it has been observed that car use per head, or total car traffic, or road total traffic has shown little signs of growth for some years in advanced economies. In some countries, and especially cities, one or more of these indicators have declined in absolute terms. In a few countries, there have been similar studies of the distance travelled by all modes added together, which have shown a similar trend in terms of national travel, though with unresolved doubts about how international air travel should be handled.

Although different definitions of traffic have been used, in most cases it is car use which has formed the largest proportion both of the level and the growth, and the label "peak car"[8] has been widely used as the summary of a debate about whether the long dominant growth in car use specifically has come to an end, is nearing an end, is turning down or is only temporarily interrupted. Since a very large part of the policy and planning of transport has been based on forecasts of future growth, the possibilities that car use may grow significantly less, stabilise or reverse are of profound importance.

As a caveat, it should be said that a full analysis of this question really should be located in much wider methodological and empirical issues of travel demand analysis. Such a wider discussion would take on board the multi-disciplinary literature on demand elasticity, induced and suppressed traffic and the effects on travel choice, in the short and long run, of infrastructure provision and policy interventions. Of particular importance is the emerging empirical evidence on the impacts of policies aimed at reducing car use, such as pricing, pedestrianisation, public transport improvements, cycling and land-use planning. While incomplete, a number of reviews of reviews and some original sources establish that very much more evidence is available on circumstances in which people reduce car use than is often assumed in debates at national level, because the best evidence tends to be specific and local. This paper does not do full justice to all those potential sources of evidence: it seeks to record the way the argument has actually developed, noting differences of definition and approach but not fully resolving them.

There is currently much work which is in progress but has not yet reached the public domain. Apart from the work referred to in this paper, drafts and suggestions are circulated, not yet ready for citation but expected to emerge in coming months, from, among others, Armoogum, Bussière, Collet, Gargett, Glazebrook, Goodwin, Grimal, Hallworth, Headicar, Immers, Jones, Jorritsma, Kenworthy, Kuhnimhof, Le Vine, Madre, Meissonnier, Metz, Mitchell, Newman, Polak, Stokes, Van Dender, Van der Waard, Villareal and Zumkeller.

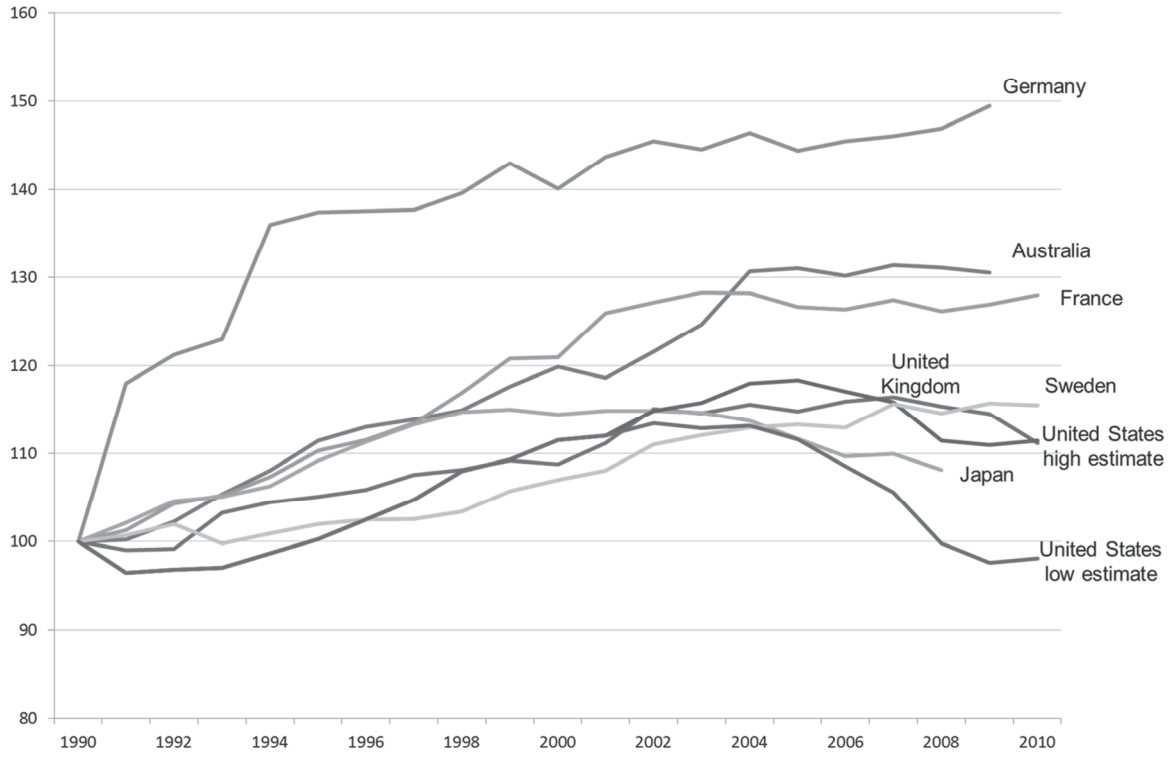
Thus, this is a rich and rapidly changing field of research, which is widely recognised as important, and is also recognised (by most if not all agencies) as having some unsolved questions which should be taken seriously. It has been put on the agenda for transport analysis by two main classes of evidence: (a) aggregate trends usually at national level, usually based on time series data within a context of traffic forecasting by national governments; and (b) the experience sustainable of specific local areas, especially cities, in the context of development of infrastructure plans and transport policies. Until now, there seems to have been little synthesis of these two, but a bridge has

been provided by studies using survey techniques, of the travel undertaken by individuals and households.

2. Aggregate observed trends at national level

An early piece of research to speculate that a levelling off of growth was occurring on an international scale was by Schipper and his colleagues (1993), and he continued this work until in 2010 Millard-Ball and Schipper published a paper with its hypothesis in the title: "Are we reaching peak travel?", which included some influential and often cited graphs on eight8 industrialised countries. In 2011, the International Transport Forum showed rather similar figures, in a discussion paper titled "Peak Car Travel in Advanced Economies?", and this was updated in 2012 as Figure 1.

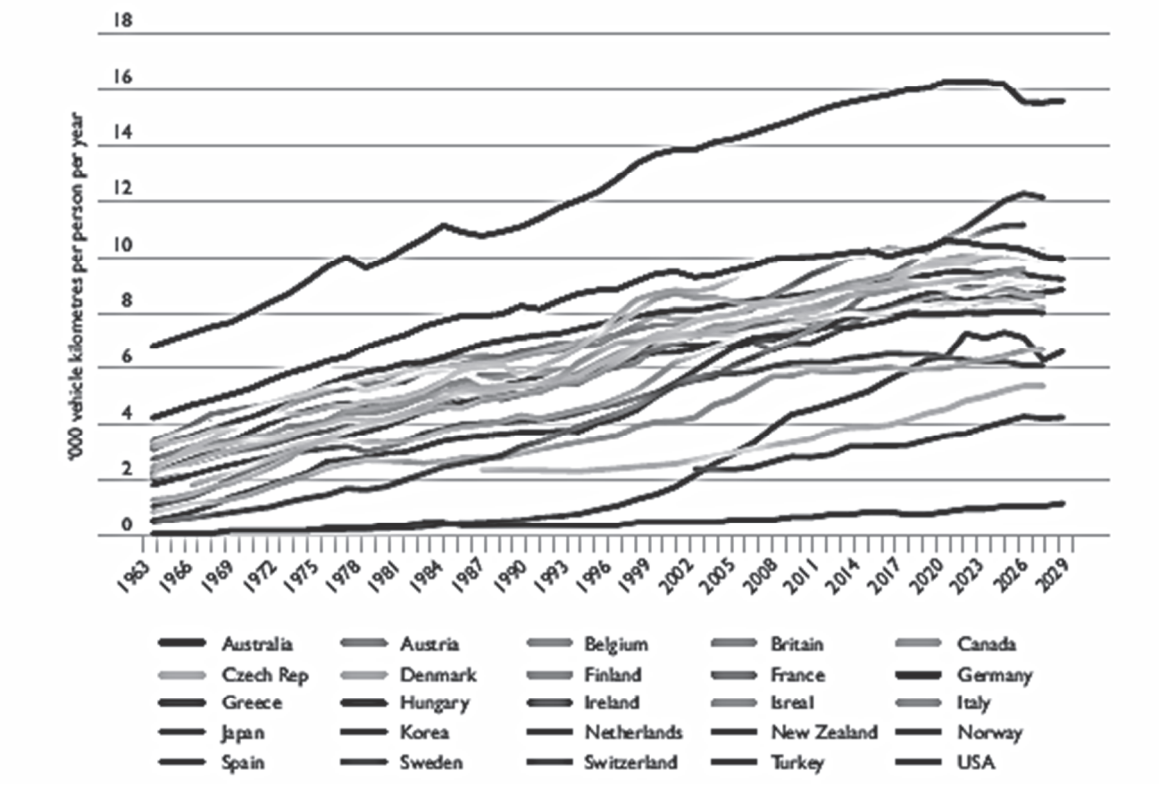
Figure 1. **Passenger kilometres by private car and light trucks, 1990-2009**
(Index 1990=100)



Source: International Transport Forum statistics.

A report by Gargett (BITRE, 2012) extended a similar database to some 25 countries, shown in Figure 2, though this relates to all traffic not just car use, and is per head.

Figure 2. **Patterns of traffic per person in Australia and 24 other countries**



Source: Gargett (BITRE, 2012).

In spite of the difference in definitions, both showed signs of what has variously been described as "levelling off" or "reduced growth". The international figures do show a substantial variation, but nevertheless there are some shifts in the aggregate trends which are not confined to a specific or very small number of countries, but seem to be a widespread phenomenon of advanced economies.

As far as the author is aware, there are no substantial suggestions that the reported trends are artefacts due to faulty measurement or misleading definitions, though some care is needed because as noted the definitions used by different authors vary. (For example, presentations on a total or per capita basis beg the question about whether it is valid to assume that growth is proportional to population, which seems not to be the case but is often assumed.) But the main thrust of the discussion has been about *why* such trends have happened, without (as yet) a full consensus but, broadly speaking, the fact of the observations is accepted with little challenge.

3. Explanations offered for the changes in trend

The range of different suggestions which have been made so far may be seen in Table 1 (next page), prepared by the author (Goodwin 2012), which is intended to be an overall summary of both formally stated research work and also intuitive and politically-driven suggestions. (The table has grown as a result of suggestions made in discussions at conferences and correspondence over the last year, and no doubt will continue to do so).

Within this seemingly endless list of possible explanations, there have been two broad schools of thought, which influence much of the research which has been carried out. These are as follows:

- The first school, often associated with governments, tends to suggest that all or most of the observed changes in per capita travel may be explained by "conventional" economic variables, notably fuel prices and measures of economic strength (such as income, national or regional GDP, unemployment). Examples of this are the analyses of the British and Australian governments in UK Department for Transport (2012), BITRE (2012). They do not come to the same conclusions about future growth, however, and even differ somewhat in the case of UK traffic growth, for which both make forecasts. Both assume that total traffic rises more or less in proportion to population growth[9], as modified by prices and economic indicators, but it seems that the role of a saturation level is much stronger in the Australian work than the British.

- The second school is much more diverse in character, but with a common emphasis on a wide variety of "other" cultural, social and policy factors, varying in importance, with a research question of whether there may have been long-lasting structural changes in the drivers and trajectory of traffic growth. While economic factors would be accepted as having some importance in all these cases, they are not seen as necessarily pivotal. It would also follow that total traffic growth may not be proportional to population growth, but be moderated by the structure and location of the population.

All such arguments can have shades of grey between one and the other, but distinguishing features tend to include the question of proportionality to population, the estimated strength of policy impacts, and the role attributed to social and cultural influences. It is interesting however that the notion of a saturation level, "natural" in some sense, can apply in both cases, so it is helpful to discuss that next.

Table 1. **Factors suggested to explain widespread reduced growth in car use, and some reduced absolute levels of car use in advanced countries**

Traditional "economic" factors of prices and incomes

- General economic conditions;
- Fuel prices, cost of learning to drive, acquire and run cars, congestion charging, insurance costs, parking costs;
- Fares subsidies on public transport;
- Changes in regulation, taxing and funding of company cars;
- Decoupling of income growth from travel growth.

Changes to the relative quality and reliability of travel

- Improvements in public transport, due to priority access to infrastructure and better operations;
- Congestion;
- Provision of cycle lanes and other support;
- Pedestrianisation of town centres and traffic calming in residential areas;
- Development of urban rail systems with consequential impacts on property values and attractiveness of locations well served by public transport;
- Reallocation of road capacity from car to wider pavements, priority lanes, etc.;
- Parking conditions and policy;
- Increased availability and lower (relative) prices of alternative long distance mode (rail, air) which may lead to substitution for given destinations but perhaps more importantly substitution of destinations and modes.

Developments in land use planning

- Redevelopment of brown-field sites and inner city areas with high densities;
- Retail and service development favouring urban localities rather than out-of-town sites;
- Inner city development of a type which becomes preferred by higher income groups and opinion formers, changing fashions away from suburbs;
- Better understanding of economic benefits of public realm improvements.

New social/technical patterns and preferences seen as influences on behaviour

- Travel time budgets, especially in the context of natural saturation level;
- Application of "smarter choices" programmes;
- Cultural and psychological shifts including a cooling or disappearance of the "love affair with the car";
- Concern with motivations less favourable to the car (notably environmental impacts and personal health);
- Various different forms of e-commerce (tele-commuting, on-line shopping, virtual conferences and meetings) and e-leisure (social networks, virtual worlds) especially associated with mobile commuting (which in turn is more favourable to public transport use than car driving);
- Social changes such that the driving license as a key rite of passage into adulthood no longer has the universality it had seemed to be acquiring, especially among young men whose propensity to learn to drive and buy a car has reduced in many countries;
- Decline of the status, fashion, social esteem, implicit sexuality and "buzz" of car ownership and use, and their replacement by other products and icons;
- Changing demographic structures and lifestyles, including those which affect the longevity of particular life-cycle stages and the locations where people prefer to spend them, for example shifts from inner cities to suburbs of young couples, returning to cities when their children leave home;
- Growth of immigrant numbers (in the broadest sense) who bring different cultural attitudes and habits of travel to their new homes, whose effects may go in either direction depending on the specific two cultures concerned;
- Shift in the direction of transmission of attitudes, i.e. from children to parents;

- Complex balance of aging and gender effects, such that women are catching up with the car access of men, men are catching up towards the longevity of women, both are living longer with a tendency to keep on with car use in the early years of retirement but then to have a longer period of life when it is less easy to sustain car use and the skills which go with it.

New patterns of work, shopping, entertainment and leisure

- Shift of certain categories of what has traditionally been considered as "personal" travel to "commercial" travel, notably in home delivery of some goods previously been transported by car;
- Telecommuting, high-technical versions of home working;
- Shifts of some travel from car to air, and from air to train;
- Reduction in traditional forms of car dependence, including by development of new patterns of car use moving away from traditional ownership to various sharing, leasing or renting schemes.

Direct and indirect effects of technologies providing mobile internet access

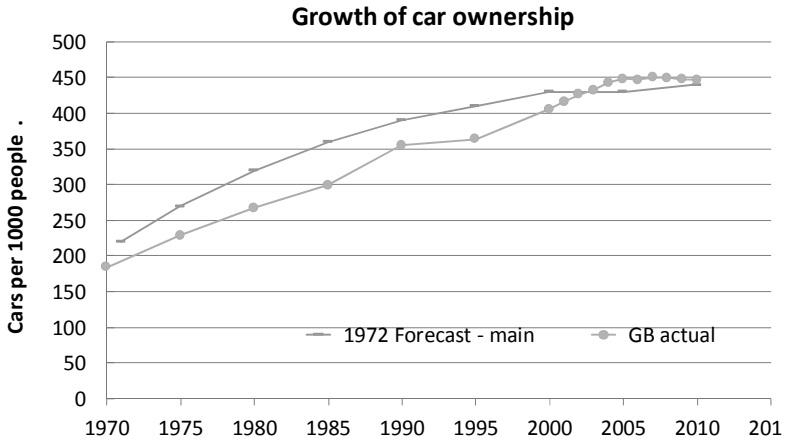
- Opportunities for entertainment, social contact and productive work during travel, tending to favour public transport more than car use;
- Better travel planning, including recovery from disruption.

4. Ideas of saturation

In the early years of traffic forecasting, it was taken for granted that at some point in the future the number of cars and the volume of traffic they would generate had an upper limit, known as the saturation level. In general this was taken as deriving from social and economic factors (sometimes described in terms such as "when everybody who wanted and needed a car would have one", *not* from the idea of a road network which would be "full up"). A generation of forecasting techniques were developed in the 1950s and 1960s, in which the most influential work was probably by J. Tanner at the UK Road Research Laboratory. The estimation of the saturation level was first done by looking at trend and cross section data, and then imposed as a parameter which gave a strong constraint or upper bound on future traffic levels. The speed at which car ownership and traffic approached the eventual saturation was thought to be influenced by incomes and (less so, at that stage) by prices. Empirical research suggested that the quality and price of public transport would have an influence, as would demographic and planning trends, but this work tended not to be incorporated directly in official forecasts, being subsumed in rather generic "external trends".

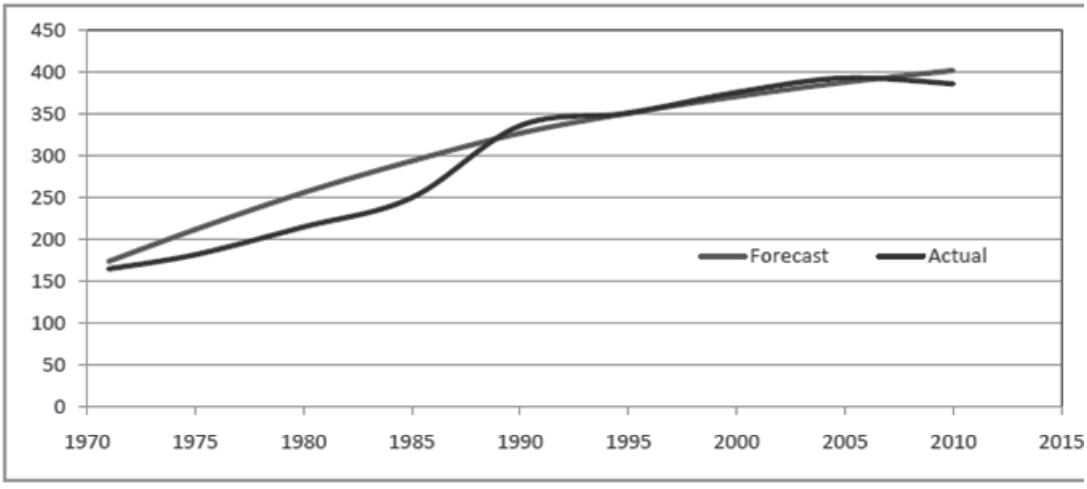
The high point of this form of forecasting was probably in the 1970s and, as it happened, a particularly characteristic application of Tanner's method, by Tulpule (1974), has recently come into view, as the timescale of its forecasts, from 1973 to 2010, enables the rare opportunity of testing the complete period of a long-term forecast against the observed outcome. This is shown, for car ownership and traffic, in Figures 3 and 4.

Figure 3. **TRRL forecasts, 1972 base**



Source: Mitchell, iammotoringfacts 2012, from Tulpule, 1974.

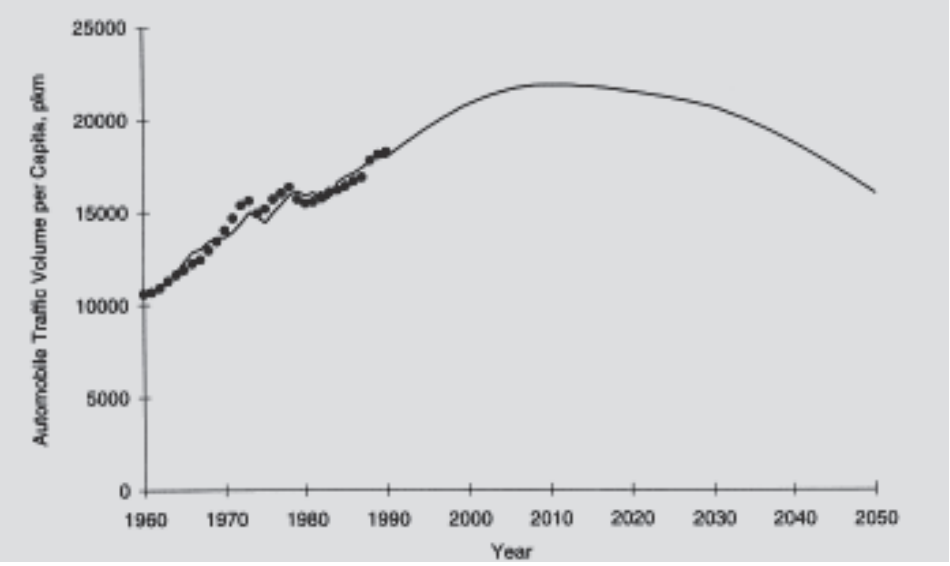
Figure 4. **Car traffic, 1970-2010, 1972 base forecast**



It is immediately obvious that the forecasts, considering they are made over such a long period with no retrospective "reinterpretation", are quite remarkably accurate. This does not indicate, of course, that the forecasting assumptions, methods, parameters and method were all justified – there are many ways in which offsetting errors can produce accurate forecasts, and indeed the method was officially abandoned as inaccurate within the first ten years its currency. An S-shaped curve including saturation can, when saturation is deemed to be far away, be quite sensitive to the effects of other factors such as prices and incomes, but as it is approached, the saturation level estimated will have an increasingly strong effect on constraining and limiting errors due to other factors. The main retrospective significance is that the forecasters of the time some 40 years ago did not think it was unlikely that an ultimate saturation level of around 400 cars per 1 000 population would occur in the first decade of the 21st century, which later forecasters (until recently) considered highly improbable.

Another forecast which suggested a peak per capita car use in North America by about 2010, and absolute decline in OECD countries as a whole, was by Schafer and Victor (2000, in calculations evidently carried out about 1996). The forecast is shown in Figure 5.

Figure 5. **Projections of peak and decline of car use by Schafer and Victor (2000)**

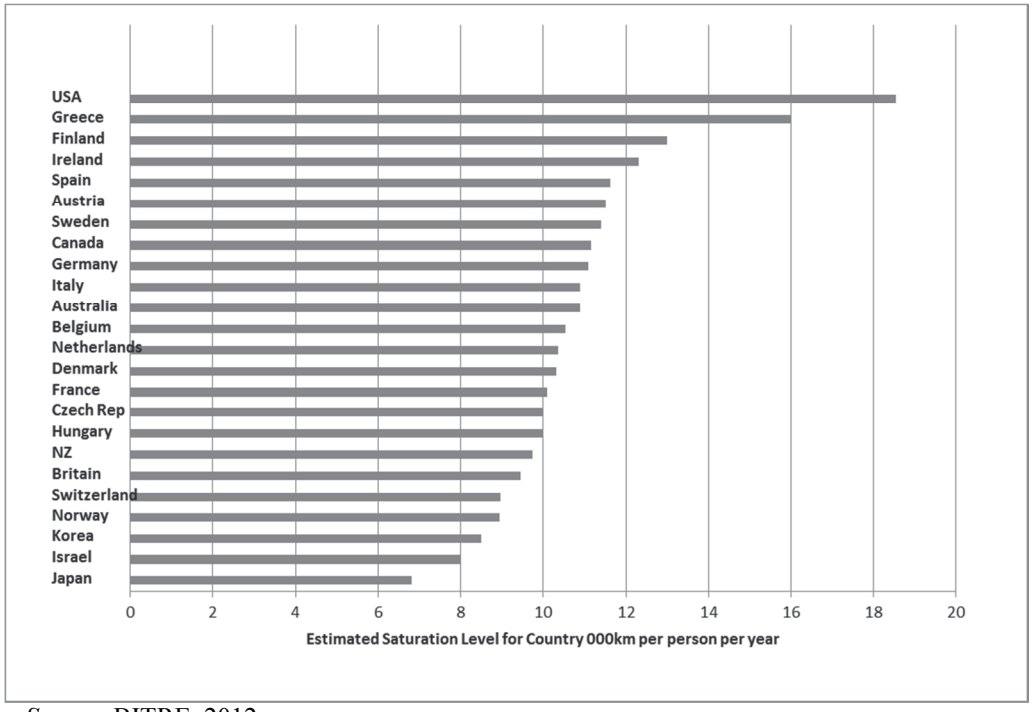


In their model, the driver of this decline was a transfer of demand from car to air, which they project would account for 36% of all global mobility by 2050, and still be growing at the expense of all other modes. The underpinning of this is discussed further below.

In Gargett's approach, the functional form chosen estimates a saturation level directly for each country studied. The saturation levels (estimated from time series data in which the specification includes separate consideration of fuel prices, a measure of economic success, and other variables) are shown in Figure 6.

The saturation estimates are generally higher than current levels, in the nature of the specification of the functions used, and in most cases sufficient evidence of a slowing down in the growth curve already enabled a definite saturation level to be estimated. There is a considerable cluster in the range 8-12 000 vehicle-km per person per year, in which the USA stands out as being exceptional (apart from Greece, which not everybody would take as credible). There is no indication that the American experience would be taken as a "target" towards which other countries are progressing, even ones which are sometimes described as similar: Canada sits between Sweden and Germany, and Australia between Italy and Belgium. The significance of these figures is not that such an approach is universally applicable, or that it will be better than locally specific estimations for each country, but that the visual impression of an approach to saturation among many countries is consistent with an econometric estimation, with around 20 out of the 25 countries showing somewhat similar values. (No saturation estimate was made for Turkey, the missing country in the figure).

Figure 6. **Saturation levels of total traffic per person redrawn from data estimated by Gargett**



Source: BITRE, 2012.

It should be noted that the functional form fitted does not allow recent declines in car use to appear as a downturn (they are explained by the other variables, or if this does not fit they somewhat depress the saturation level). They also do not allow consideration of the effects of other factors outside the model – for example, quality of public transport or other car-reducing policy measures – which are assumed to be zero or random.

The work by Tanner and Tulpule, Schafer and Victor and by Gargett, representing substantially different approaches, nevertheless indicates that current discussions of the idea of an upper limit on car use or traffic are not a radically new concept. There is a pedigree of many decades.

But the idea of saturation may be derived from quite different approaches. In the early 1970s, that the first attempts were made to build into forecasting an observed regularity[10] that the average amount of time spent travelling was remarkably stable, for reasons which were unclear but in some authors' view represented a fundamental aspect of human behaviour, the travel time budget. Tanner and Tulpule made no use of this in their saturation levels, but Zahavi (1974) built such a constraint into his proposed forecasting model, initially in relation to the time spent travelling by car, and later by all modes taken together. This hypothesis remained a magnetic idea to researchers looking for aspects of stability which could be used to give reasonable constraints to otherwise limitless trends. It is interesting to note that two researchers in particular have applied the idea of stable travel time budgets to the issue of saturation in mobility, namely, Schafer and Victor (2000) and, more recently, Metz (2010). Their analyses are radically different and incompatible, but both lead (via a different chain) to the conclusion that stable travel time budgets would be expected to lead to stable or reduced car use. The two arguments may be summarised as follows:

- **Schafer and Victor (2000):** there is a very strong elasticity of total distance travelled (by all modes) with respect to income, but the total amount of time spent on travel is stable. Therefore as income increases, this drives the transfer to faster modes. Some travel by slower modes is displaced by travel by faster modes. Air travel being faster than car, this will eventually replace a substantial proportion of car use, which having itself displaced much public transport and walking, will stabilise and then decline. (This prediction, though controversial, and focussed more on predicting a very large increase in air travel, was made before the stabilisation and reduction of car use was recognised).

- **Metz (2010)**: the number of destinations that can be reached within a given distance increases, on average, with the square of distance, but the additional utility to be gained from a more distant destination decreases the more nearer destinations are passed. Since total travel time is stable, there is increasing resistance to travelling further, and the positive income elasticity declines in importance compared with the travel time constraint. So total distance travelled tends to saturate, and total distance travelled by car (influenced by cost and land-use constraints) will saturate also.

Although both approaches rely heavily on the observation that constant travel time is rather, or completely, stable, the key difference between them is that Schafer and Victor would expect an income elasticity which continues to be high and a powerful driver, and Metz expects a declining income elasticity of reducing importance. This is in principle empirically testable, and is discussed below.

Although Metz states his argument in terms of a stable travel time budget, a closely similar result can be obtained without this constraint. A more general hypothesis, due to Van Dender, is that because the *total* amount of time available is always constrained, the opportunity cost of spending time in transport rises as income rises, except when time spent in transport can be combined with other activities such as working on public transport, which will give an incentive for modal shift from car to those forms of public transport where this is suitable. A different insight is provided by those forms of travel demand models which express money in the form of time rather than time in the form of money. Most of its results are symmetrical but the implication is that income increases lead to a declining marginal utility of money rather than an increasing marginal utility of time, this being intuitively a more sensible interpretation of the observed increase in "value" of time.

Thus the simplest hypothesis, and the one rooted in the longest history of transport analysis, to explain the observed trends is the proposition that the long term growth in car use would naturally be expected to saturate, and there is nothing special about "now" in terms of timing: it is happening now just because it has reached the relevant level. This was, indeed, forecast nearly 40 years ago. There would be a variation among countries about how close to saturation they are, some variation in the level of that saturation due to specific local circumstances, as yet undefined, and differences about whether that would also happen to all modes including aviation, but it would be a "natural" and not unexpected development.

However, just because a relatively simple econometric model including a saturation level can be consistent with observed trends does not, of itself, prove that the explanation is adequate, and this has become apparent because there are other phenomena, which have led researchers to look at deeper explanations.

5. Explanations based on wider social and cultural factors

While it would be expected that different specific circumstances and features would apply in every country or indeed region, there have been some common features widely noted in recent, which seem to apply in many countries, and which become apparent at a more disaggregate level than national trend data, for specific groups of people or places.

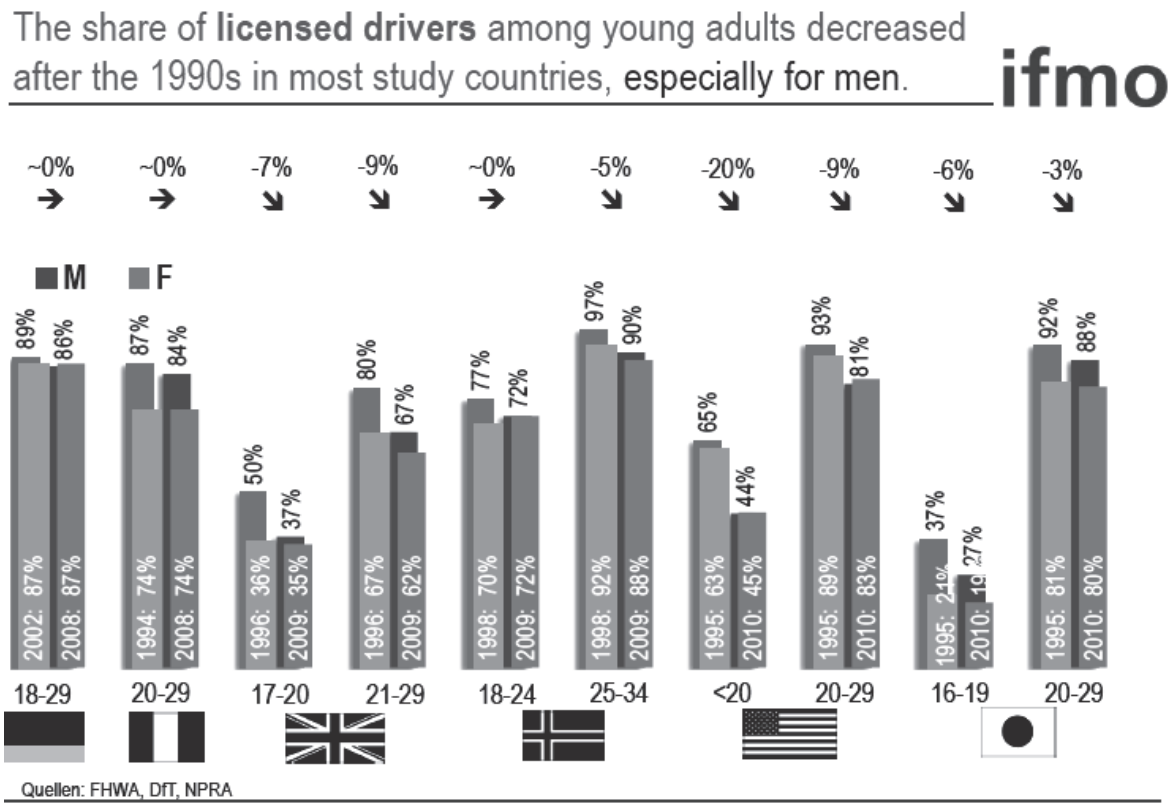
The common features which many commentators have recently found most illuminating include the following.

- A strong age relationship such that the first, or biggest, changes in travel behaviour are seen among the young, especially young men.
- An income relationship such that the long noticed importance of income growth as a strong driver of traffic growth is weakening, or in reverse.
- The existence of downward trends in traffic in certain cities which are growing in population, employment and wealth; this is usually associated with relationships with planning outcomes, development density, relative importance of "greenfield" and "brownfield" locations for new development, and policy initiatives including pedestrianisation, new tram systems, traffic calming, and in some countries very strong growth in cycle use.
- Observation of strong growth in social networking, mobile computing, and internet-related economic activity such as shopping, tele-commuting, teleconferencing.
- A summary of some of the main research findings in these areas is given in turn.

5.1 Age-related changes in trend

An international comparison by BMW in Germany (Kuhnimhof, 2012) has suggested that the share of licensed drivers among young adults decreased after the 1990s, especially for young men, as shown in Figure 7.

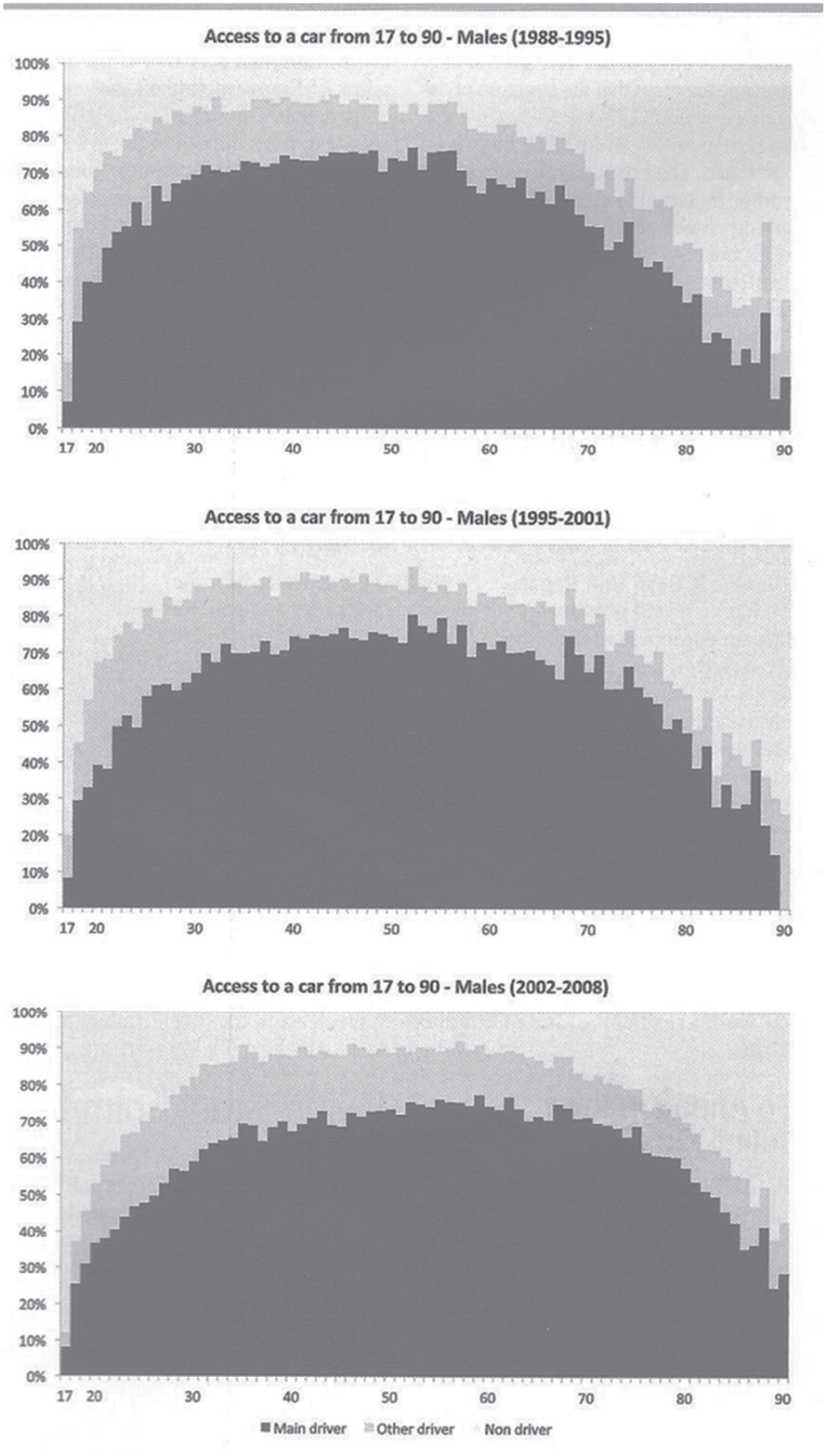
Figure 7. **The share of licensed drivers among young adults decreased after the 1990s in most study countries, *especially for men***



Sources: US Federal Highways Administration, UK Department for Transport, Norwegian Public Transport Administration.

The first person to have noticed this trend seems to have been Noble (2005) and detailed analysis of UK data has been carried out also by Mitchell, Le Vine and others, including Stokes (2012[11]) whose analysis has a particularly interesting presentation in the form of quasi-dynamic cohort movements, separately from men and women, over a twenty-year period, 1988-2008. His results are shown in Figures 8, 9 and 10 below.

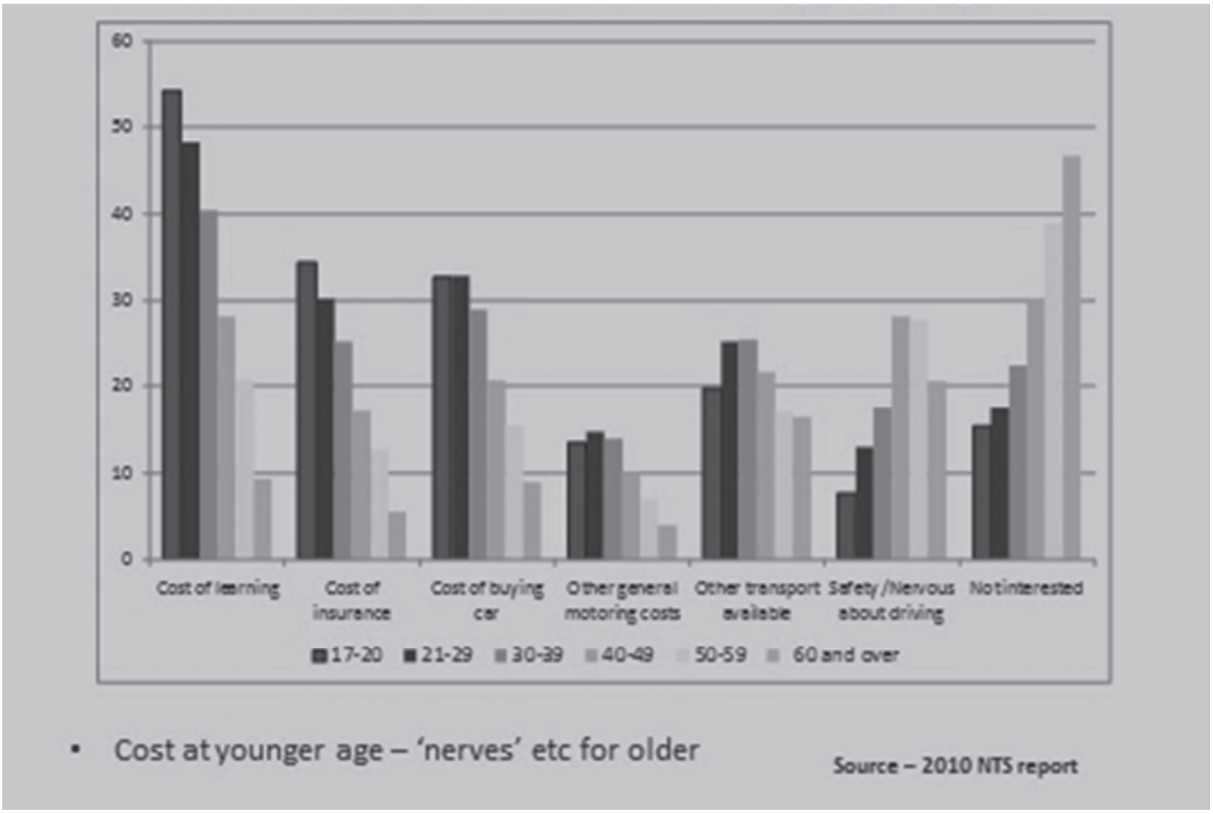
Figure 8. **Access to a car from 17 to 90 – Males (1988-1995)**
Figure 9. **Access to a car from 17 to 90 – Males (1995-2001)**
Figure 10. **Access to a car from 17 to 90 – Males (2002-2008)**



Stokes notes that what started as a reduction in the propensity of young men to learn to drive continued over the period. Even though many of the individuals announced their intentions to "delay" learning to drive rather than not to learn, the decision seems to be sticky, and a smaller proportion actually get licenses than plan to do so (and apparently the ones who do get licenses, late, then drive less). The reduction evolves through the population as people get older: at the same time, however, an increasing number of older people have cars as a result of their own decisions, when younger[12]. Car use among young women did not show the same features initially, but may have started to more recently.

Some surveys have asked people of different ages their own perceived reasons for not learning to drive. The results of a UK survey are shown in Figure 11. They indicate that cost-related factors are mentioned more frequently by the young, and other factors more frequently by the old, though it is interesting that "other transport available" is quoted by up to a quarter, and "not interested" by 15% to nearly half.

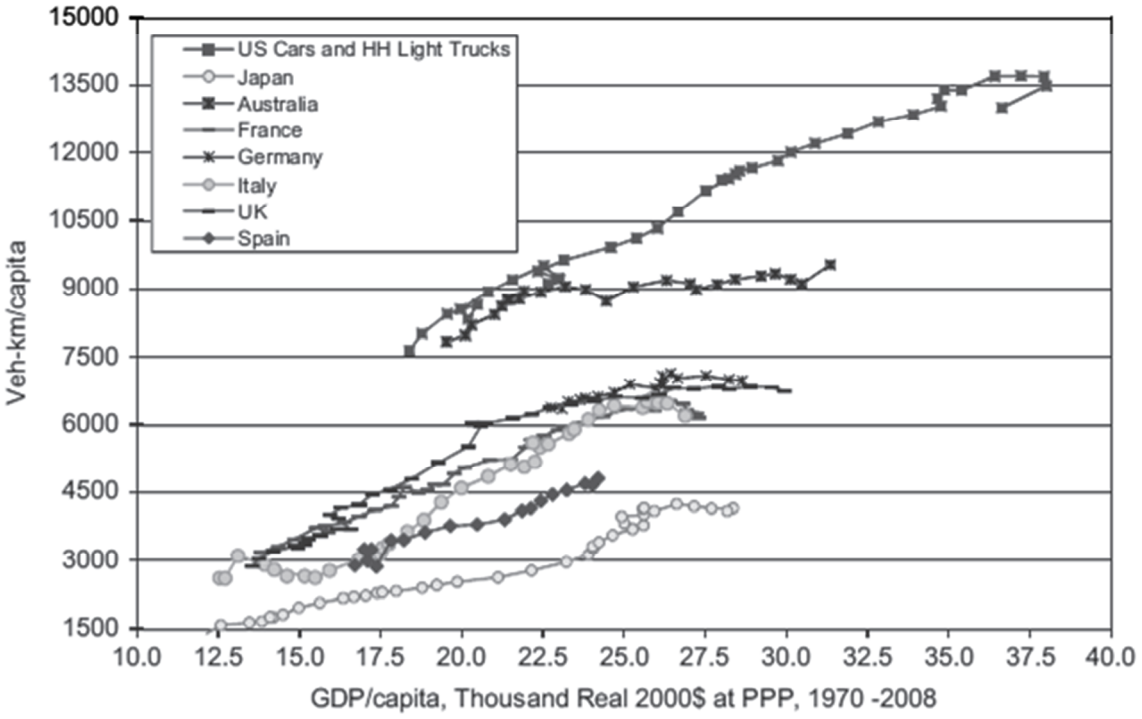
Figure 11. **Reason for not learning to drive, by age**



5.2 A weakening effect of income

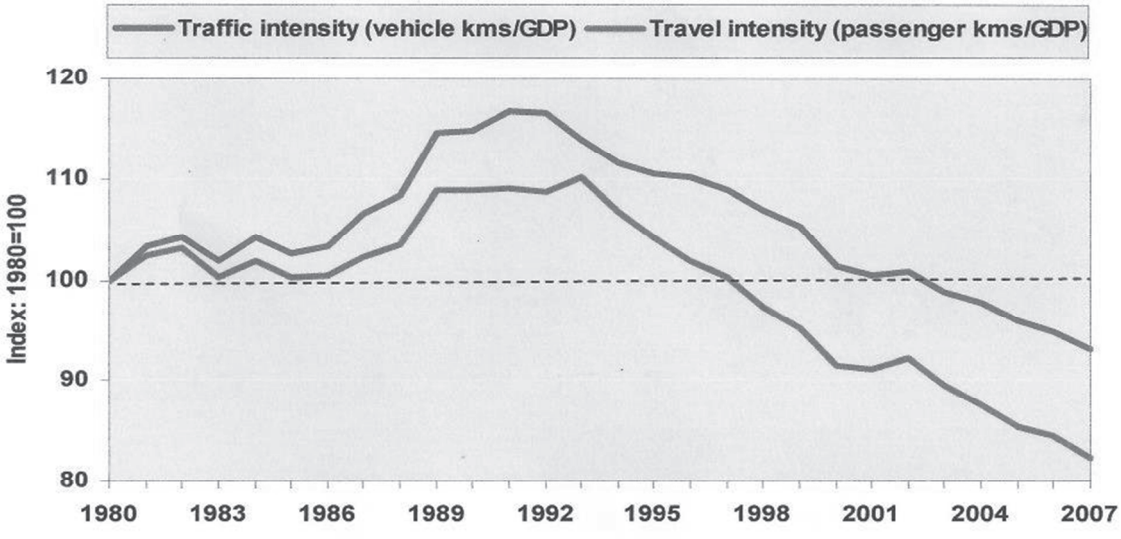
It is interesting to note that Schipper's last work focussed on income effects, with the results shown as Figure 12. He suggested that this showed a progressively weakening effect of income growth on travel, as saturation levels were approached.

Figure 12. **Vkt/capita for cars and household SUV or light trucks *vs.* GDP per capita in 2000 USD, converted at purchasing power parity**



Another indicator of a weakening relationship between income and traffic is shown in a shift of trend of the transport intensity of economic growth in GB, which was increasing in the period from 1980 up to the early 1990s, but then reversed and has been decreasing since (often called "decoupling" transport growth from economic growth). This is shown in Figure 13.

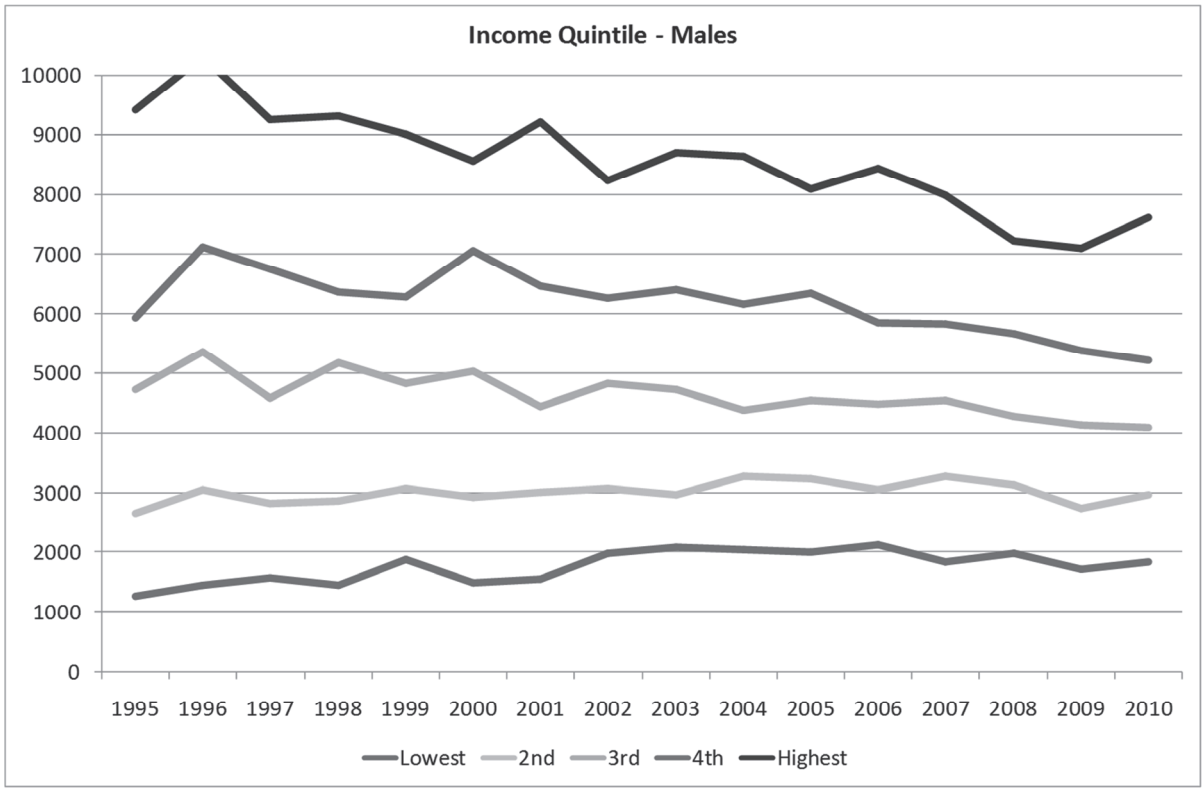
Figure 13. **Transport intensity in Great Britain** (kms per unit of GDP)



Source: Department for Transport (2010).

A particularly interesting result has been reported by Stokes (2012) which has not (as far as the author knows) been noted elsewhere, but raises an important question about the effects of income. This is the suggestion from UK National Travel Survey data that car use by men in the highest income group has reduced most, while the lowest is still increasing, shown in Figure 14.

Figure 14. **Reduction in car use by men in the highest income group**

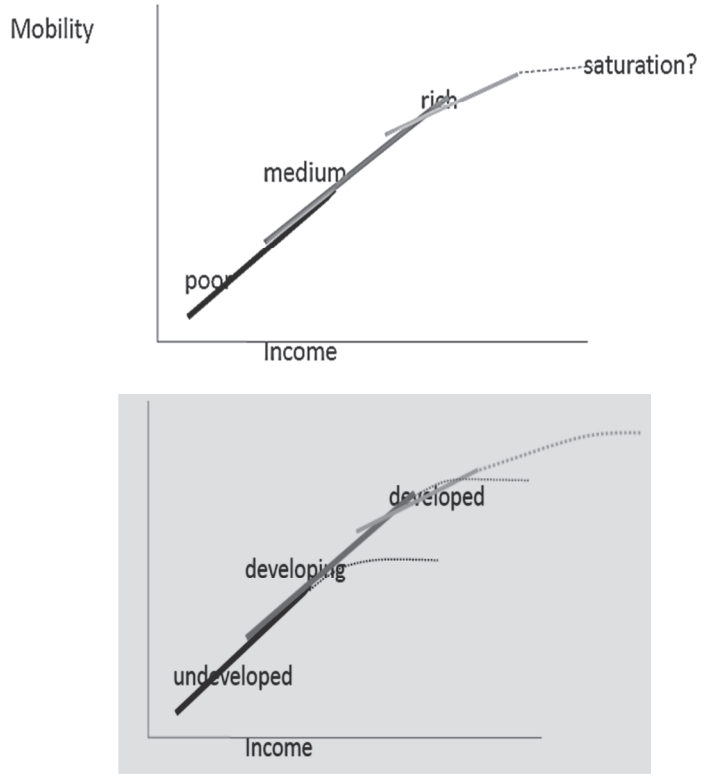


Source: Stokes (2012).

This is not a regression towards the mean effect, since in the period concerned men in the highest income group were getting richer, not poorer, and is not what one would expect at a time of economic difficulty and pressure. It is however consistent with (though does not prove) the idea that wealthier people have found it easier to develop a less car-dependent life style, which is plausible.

The possibility of a reducing role for income as the core driver of traffic growth has important implications for global trends in which there has often been a formal or informal presumption that the future for poor countries, as they become richer, is to be taken as following the same historical trajectory of the richer countries. In the limit, this would mean, for example, that Europe follows America, Asia follows Europe, Africa follows Asia, and so on, all ending up with American styles of car domination. Saturation, if it occurred, would be at some global level greater than the current US experience[13]. An alternative hypothesis would postulate that different groups of countries, or individual nations, would see their own reduction in historical growth rates.

Figure 15. **The hypotheses of a single pathway to saturation led by income, versus multiple saturations for different countries**



5.3 A possible effect of mobile computing and associated cultural changes

In a very early speculation, Hallett and Stokes (1990)[14] considered whether the influence of advertising on attitudes to car ownership could be modified or offset by new technology. They wrote:

> "*Another possibility is that some new product could hit the market which would make the car redundant in the psychological sense. It is hard to imagine what this could be. Computers seem to be the products which come closest to satisfying the kind of psychological desires which cars cater for. Some computing product (probably portable) could maybe be produced which would cater for power, or freedom desires, although it does not seem at all likely at the moment*."

However, the idea took off again in the early 2000s in studies which considered whether telecommuting and other information technology might reduce the demand for travel, a widespread view at the time being that there was little evidence that this was happening, and the argument that it might was ambivalent: internet contact might widen the geographical spread of personal networks, and therefore generate more travel rather than less.

It is intriguing that Hallett and Stokes' reference to "some computing product (probably portable)" has turned out to be one of the most important trends of the last two years, and there is much speculation that mobile information technology is having as big an effect on travel choices as it is manifestly having on activities undertaken during travel. There is much evidence on the exponential growth in use of mobile information technology for entertainment, social networking, and as potential

travel substitutes such as tele-commuting, tele-shopping, teleconferencing. This is not in doubt. It is also known that this has been a youth-oriented market albeit subsequently penetrating into all age groups. A frequent feature of professional discussions on the topic is anecdotes along the lines of: "For me, getting my licence and my first car was a very important part of growing up, but my son/daughter/nephew/niece doesn't seem bothered – they are more interested in their phones, tablets."

Prima facie, there is a very strong reason for expecting connections between observed reductions in travel and increased use of mobile information systems, but the author is not familiar with current empirical studies directly investigating this in the context of current technologies, and this remains a gap to be filled. In particular, not a single case is known where government transport agencies are funding current research on the impact of smartphones on travel, for example.

So are there effects on transport? Some have already been observed – the effect on the "value" of time, the nature of journey planning and especially the ease of changing plans to cope with unexpected incidents or just a change of mind, and so on. But underneath all that, there is a change in the nature of what we mean by a primary activity. A phone used to be something you might use while travelling; now travelling is something you might do while your attention is actually on a web connection. There is no consumer object so rich in status and symbols: it seems to be the icon of the age, just as cars used to be. Practically, the user does not need expensive lessons, a test, a licence or insurance, and it will not be confiscated by law for misuse.

Meanwhile one notes the ubiquitous iconography of advertising. (Slogans such as "I love my iPhone" are as prevalent as the use of "love affair with the car" images since the 1950s.) The images are there though the quantitative evidence is only now starting to emerge.

5.4 Traffic trends in cities and other urban areas

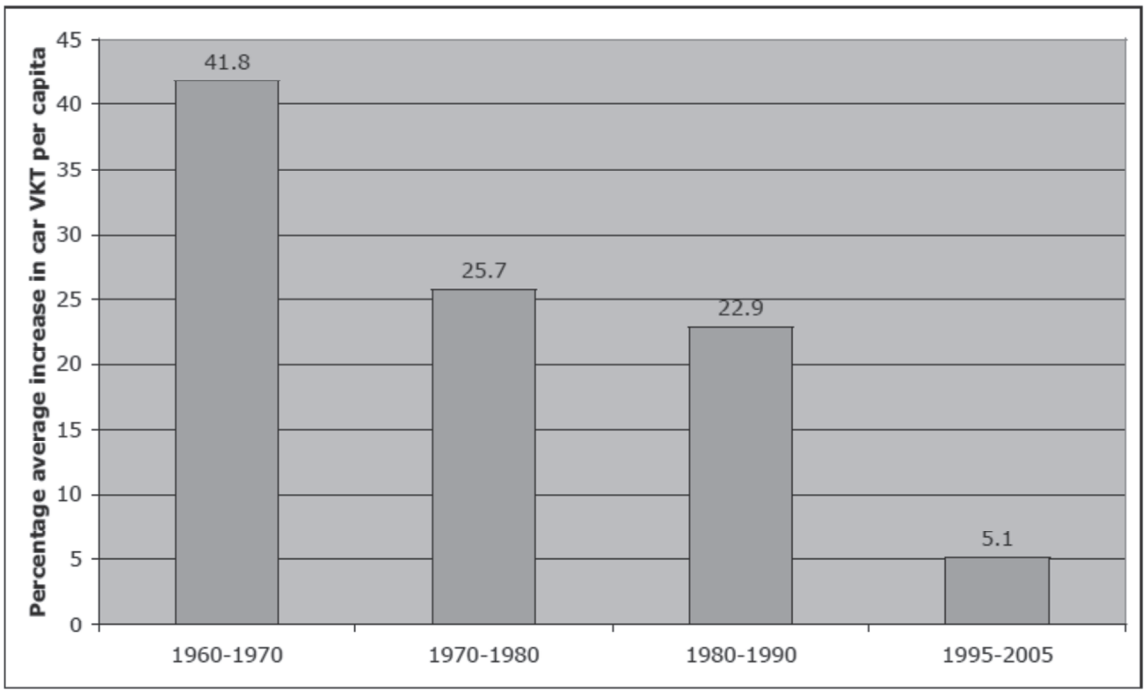
National travel statistics are composed of travel by different individuals in different places, and it is likely that the search for understanding and explanation will increasingly focus more on local trends than national ones. Within this, an important argument is widespread that it is in cities where the influence of policy, alternative modes to the car, and physical barriers to car use are most effective. The proposition is that the national trends cannot be understood without seeing what is happening in the cities.

Newman and Kenworthy (2011) showed that the growth of car vehicle-kilometres per person declined over a 40-year period up to 2005, when it was still positive on average, but low, as shown in Figure 16.

Puentes and Toner (2009) suggested that the growth of per capita car use in US cities was slowing throughout the 2000s, and declined from about 2005. More recent work suggests that car use in some large European cities has been declining for a decade or more, and this is discussed below.

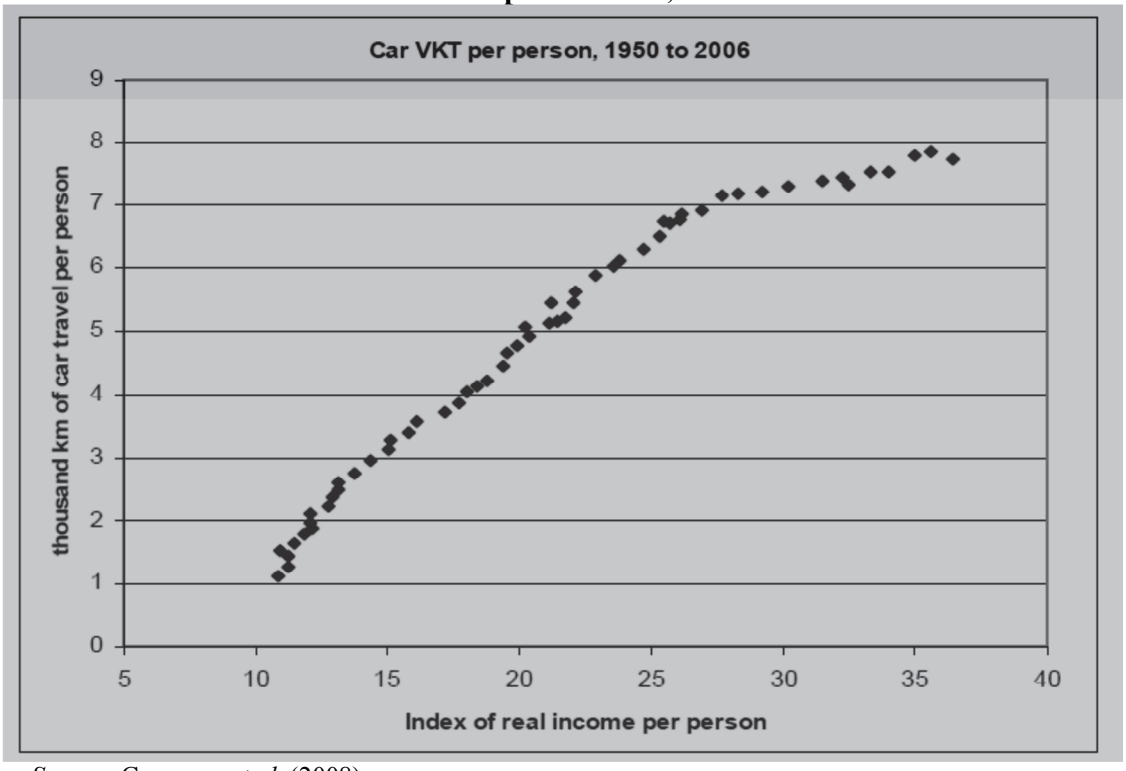
A study by Cosgrove *et al.* (2008) for the Australian Treasury particularly noted that the relationship between income and growth in car use in metropolitan urban areas had flattened substantially from the 1980s onwards, as indicated in Figure 17.

Figure 16. **Growth in car use per person per decade in 25 cities,**



Source: Newman and Kenworthy (2011).

Figure 17. **Per capita car travel related to per capita income in Australian metropolitan areas, 1950 to 2006**



Source: Cosgrove *et al.* (2008).

This discussion is continued with respect to policy influences which are focussed especially on urban conditions.

Wider evidence on policy impacts on car use

In terms of policy content, evidence available includes the following key studies (as well as more detailed case studies on a very wide variety of locally specific initiatives):

- The *pedestrianisation of large areas of city centre*. This may be counted as one of the great success stories of transport and land-use policy in recent decades, with many hundreds of cases, very well embedded in cities, with the UK experience supporting but mostly being somewhat less ambitious than the best European examples. There is good (and bad) practice on how public transport and parking policies can strengthen or weaken the impacts, and it is possible to give well attested rules of thumb about orders of magnitude of impacts and the conditions and dynamics of public support, but there has been much less successful interest in detailed modelling, forecasts, and formal ex ante or ex post appraisal, using either classical or behavioural theories.
- The evolution of ideas about *traffic calming, shared space and quality design*, mostly in residential areas, ranging from entirely new principles of street layout and design in, for example, some Dutch suburban areas, to the cheapest and nastiest (but sometimes effective) retrofitting of speed humps in traditional local streets.
- A substantial body of experience about *public transport*, including high-speed, long-distance rail services, and local street-running metro systems with reserved or priority track access. (This evidence includes important classical analyses, such as effects on local property markets, which are usually positive and can be quite large, e.g. 10%-20% house price premiums); also effects of bus priorities, busways, bus marketing initiatives and other promotions.
- *Cycling* initiatives are now widely and long-enough established to identify cases of reversing a long-term downward trend and replacing it by very substantial growth.
- There are separate bodies of empirical study about *individual choices and behaviour*, of which the most widespread have been repeated cross-section studies before and after a policy intervention (e.g. ranging from studies of the effects of reducing *public transport fares* in the 1980s, studies of both increasing and reducing *road capacity* in the 1990s, monitoring *road pricing* in London and Stockholm, and the range of *smarter choices* initiatives, including workplace and school travel planning, personalised travel advice, marketing, car sharing or pooling or clubs.
- Qualitative and quantitative studies of attitudes about existing behaviour and intentions or aspirations about future changes in behaviour, usually finding quite large minorities declaring themselves willing to change their choices for a wide variety of reasons (including health as much as, sometimes more than, traditional transport objectives), and with more or less strongly expressed caveats and conditions about the quality of alternatives provided. (This body of work usually finds a minority, but significant numbers, of people who say they would like to drive less than they currently do, which is a potentially important section of the public in early responses). There are reservations about whether there is a gap between intention and actual behaviour, and very little evidence to test whether the people who say they would like to change their behaviour are actually the ones who do so. This critical evidence gap arises because there are no known longitudinal attitude studies of any scale, though there have been some small-scale pilot studies with helpful results.

- There is a very important but usually ignored evidence base of longitudinal studies of reported behaviour, including ten years or more of data of how commuting trips in particular change over time for specific individuals. This enables measurement of "churn" and the volatility of choice from day to day or from year to year. It is crucial in understanding the potential for future change, because of the axiom that analysis of change must proceed from evidence on change, not evidence on states. (Most of the received wisdom that "travel choices are too difficult to change" stems from this misinterpretation).
- In the Sustainable Travel Towns report, by Lynn Sloman and colleagues, car driver trips per person declined by 9%, and car driver distance per person by 5% to 7%, from 2004 to 2008. But interestingly, when Sally Cairns compared these results with the National Travel Survey results for other towns of similar size, she found that the car use had gone down there as well, though not as much: car driver trips per person by 1.2% and car driver distance per person by 0.9%. Studies by Carmen Hass-Klau of the impact of building new urban tram systems in European cities found that car ownership was reduced in the neighbourhood of the trams, by an average of 13%, even though these areas were also affected by gentrification and increased property values as a result of the same improvements: they became richer.
- It is worth mentioning also another type of greatly underused evidence, namely, the international pooling of data from local initiatives and schemes. Two sources stand out (though there are many more). These are (a) the ongoing Victoria Transport Policy Institute On-line TDM Encyclopaedia, at www.vtpi.org/tdm/index.php, led by Todd Littman, which is a portal to much of the world's literature on the subject (albeit rather North American in its practical orientation), and (b) ELTIS (European Local Transport Network Information Service) at www.eltis.org which, as at January 2011, contains summary descriptions of 1 275 transport initiatives in European cities. Updated frequently, though detailed information then needs to be gained from the contacts given there. Note that much of the German, French and Spanish experience is not reported in English and is therefore inaccessible to many monoglot English speakers. After a period in which Germany was widely recognised as the leading country for sustainable urban practice, that lead has probably now passed to France, whose policies are radical and effective, especially in the reallocation of road capacity from cars to sustainable modes and walking space, though little known in the UK apart from the Paris Velib' scheme, which was the model (though considerably bigger) for London's "Boris Bikes".

As an overview, this body of evidence suggests that responses of car use to policy initiatives are often rather small in the short run, but build up to very much more flexible life-style choices in the longer run, defined as the period of 5-10 years and in some cases longer, in which habits are eroded and new ones form, with a particular importance of life-cycle or other changes as being the triggers which enable responses to changed transport conditions. There is a very large volume of empirical and case study evidence about the effect of changes in price, speed of travel, quality, information, new infrastructure, better use of existing infrastructure, planning, and other factors which can be influenced by public or private interventions. The evidence available is rich concerning reductions in car use up to about 20%-30%, but very sparse, at the present time, for changes greater than that. A summary of useful references is given in Table 2 below.

Table 2. **Selected references with overviews and synthesis of empirical evidence on implemented transport initiatives and their effects**

Citation and date	Sources used	Coverage	Comments
European Conference of Ministers of Transport (2007) (Book, 263 pp)	63 references and a review of progress in 51 OECD and ECMT member countries.	All modes, including freight, shipping and aviation	Identifies 400 measures, with orientation to efficiency and supply-side measures.
Balcombe, R. *et al.* (eds.) (2004) (Book, 237 pp.)	About 600 references, including good coverage of grey literature.	Public transport fares elasticities by area, purpose, time of day and other dimensions; quality of service, income, car ownership, and various policy impacts.	Replaces an influential earlier work (Webster & Bly, editors, 1980). Good on short-term/long-term distinctions.
Cairns, S., C. Hass-Klau, P. Goodwin (1998) (Book, 259 pp.)	About 150 references, incl. many semi-published, some non-English (notably German), and original material from interviews with local authorities.	Effects of reducing road capacity by pedestrianisation, bus lanes, and evidence from accidents, disasters, maintenance, etc. (complement of SACTRA report on induced traffic).	Updated in a short paper by Cairns *et al.* (2002). Also contains useful summary of literature on dimensions and dynamics of changing behaviour. Demonstrated that volume of traffic often reduces by 25% or more following pedestrianisation and similar policies, though this can be reversed by inconsistent policies elsewhere.
Cairns *et al.* (2004) (Book, 676 pp.) www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt	About 300 references plus citations from sets of interviews in 24 case study locations. Includes many sources in the public domain, but not easily accessible.	Workplace and school travel plans, personalised travel planning, public transport information and marketing, travel awareness campaigns, car clubs, car-sharing, teleworking, teleconferencing, home shopping.	(Sometimes called the "soft factors" report). Concluded that there is potential for Smarter Choices to reduce traffic volumes by 11% nationally, maybe 20% in peak period urban conditions, with a ten-year build-up and serious commitment.
Commission for Integrated Transport (2007) (Booklet, 105 pp)	About 120 references	Contribution of transport to carbon reduction.	UK statutory advisory body.
Goodwin (2007)	Shorter version of "Changing Travel Behaviour", produced by the ESRC Transport Studies Unit 2004.	Overview of potential for reducing car use.	This was a major research programme undertaken as the core theme of an ESRC "designated research centre", 1994-2004. Included analysis of the natural "churn" in choices, such that over a five to ten-year period such a high proportion of the population had experienced "life-events" that their travel behaviour was easier to change than in the short run.

Table 2. (continued) **Selected references with overviews and synthesis of empirical evidence on implemented transport initiatives and their effects**

Goodwin, Dargay and and Hanly (2004)	About 85 references in the last ten years. Source literature about 500 references).	Road traffic and fuel consumption (includes some freight indirectly, but mostly personal).	Companion paper to Graham and Glaister in same journal, updating earlier literature reviews by Goodwin (1992) and Oum *et al.* (1992). Other reviews by Espey, and Sterner & Dahl. Reinforced earlier conclusion that long-term effects are about twice as great as short-term (one-year) effects, from econometric evidence.
RAC (1995) (Book 153 pp.)	About 85 references.	Overview of factors causing car dependence and possibilities of reducing it.	Suggested that the proportion of truly car-dependent trips was significant, and growing, but 20% or more of car trips were relatively easily diverted.
Cairns, S., S. Atkins, P. Goodwin (2002)	18 references, mostly UK.	Updating extra information related to Cairns, Hass-Klau and Goodwin (1998), see above.	Broadly consistent with earlier report above.
Avineri, E. and P. Goodwin (eds.) 2010	122 references.	Comparison of experience, theory and evidence on behavioural change in two different sectors, health and transport. Includes discussion of "nudge" methods.	"*…an approach which recognises non-economic as well as economic motivations for behaviour must be able to give better insights into how change works; policy interventions can therefore be more successful as well as less intrusive. 'Nudge' approaches are advocated as a cheap and uncontroversial alternative to more challenging public initiatives; however, advantages sometimes claimed are almost certainly overstated; we judge it unlikely that there is a large latent body of easy, cheap, hardly noticed initiatives that will have big effects without the need to consider more substantial intervention. The real promise seems rather to help to design the bigger initiatives better, that is to add 'nudges' to improve or speed up the effects rather than as a replacement for other interventions."*
Sloman *et al.* (2010)	Empirical analysis of data, so references only as sources for analysis.	Impacts of initiatives in Darlington, Peterborough and Worcester.	Found car trip reductions of 9% and increases in walking, bus and cycle trips of up to 30% (different balance in each town), less than "Smarter Choices" report but for less expenditure over a shorter period, so broadly consistent.
Victoria Transport Policy Institute **On-line TDM Encyclopaedia**, at www.vtpi.org/tdm/index.php, and **ELTIS** (European Local Transport Network Information Service) at www.eltis.org			Two exceptionally useful on-line evidence resources. See text.

6. A research agenda

6.1 What is the research question to be addressed?

We have an expanding set of observations, in many countries, showing features of car ownership and use in recent years which are different from previous decades. These include at the aggregate level a long period of stable car use per head, and a shorter period of declining car use per head; and at the less aggregate level the appearance of different trends for different types of area and person. Forecasts of future levels of car use (and its consequences for congestion, environment, economy, mobility, etc.) depend on understanding why the current and recent trends have changed. Therefore the task is more fully to describe what has happened, in ways which can test the strength of different explanations.

6.2 What alternative hypotheses have been suggested?

Over the last few years, three main alternative explanations have evolved. They should all be treated as hypotheses to be assessed, not revealed truth. In summary:

a) **The "Interrupted Growth" hypothesis ("IG").** This states that the main reasons for recently observed changes in trends are the effects of three key drivers, namely, income measured as GDP per head, population and fuel cost of motoring. The strength of these factors is broadly known, and reasonable assumptions about the future changes in national income, population and fuel price combine to suggest that car traffic will continue to grow, albeit at a slowing rate, for several decades into the future.

b) **The "Saturation" hypothesis ("S").** This proposes that car use per head has broadly already reached, or is close to, the maximum level it ever will, because more car use does not give benefits greater than the cost in money, and especially time, of doing so. Future increases in income will not generate more car use. Future levels of car use will be influenced by population, but not proportionally because increases housed within urban areas will be served partly or mostly by public transport, walking and cycling. The future will show rather stable levels of car traffic.

c) **The "Peak Car" hypothesis ("PC").** This considers that car use per head is passing through a peak and the current downturn may be an early sign of a long-term decline in car use, due to a complex combination of drivers in which economic influences are modified by policy, attitudinal, social, technological and cultural changes.

The nice thing about these hypotheses is that they are quite distinct, and represent all three logical possibilities (increase, level, decrease). In reality, all institutions and individuals surely accept that there will be *some* effects of most or all of the available driving factors, the difference largely being about their relative strengths, so that there are grey areas of overlap: logical possibilities of one model being appropriate for one area and a different model being appropriate for a different area, or at a different time, for example.

Thus the question arises of how different the hypotheses are? In the very short run, they are identical: they all "fit" current experience. In the medium run (say 5-10 years), Saturation and Peak Car will look rather similar, but Interrupted Growth is distinct on its own. Intriguingly, in the longer run (say, 15-40 years), this changes: Interrupted Growth looks more and more like Saturation, albeit at a higher level of traffic, and it is Peak Car which becomes more distinctly different.

Subject to the research approach described below, it seems unlikely that any of the three hypotheses can be firmly ruled out with confidence *and consensus* over the next two or three years. So the question will need to be addressed about how to sustain efficient transport decisions in the context of continuing uncertainty, which is a quite different problem than the use of a rather narrow envelope of "high" and "low" forecasts, mostly depending on different assumptions about factors like income growth.

By definition, all three propositions make a plausible explanation of observed trends at the aggregate national level. Although further general exploration of the data will certainly be helpful, there seems to be a particular type of further research which will give the greatest dividends. This is to define specific hypotheses about trends which are already observable now, which would look *different* according to the three hypotheses. Then a test of the relative merits of the different approaches is to be sought, not just in whether they "fit" the aggregate totals, but which best accords with the other accessible information. The following table gives some example tests, to clarify the point, though expecting that there are many more, and that each can be more precisely and subtly defined.

Table 3. **Tests of evidence tending to discriminate among the three hypotheses, IG (Interrupted Growth); S (Saturation); PC (Peak Car)**

Phenomenon	Nature of Test	Inference	Notes
Timing (a general approach which should modify all the others, below**).**	Do the drivers reasonably closely **precede** the effects?	Contradictory evidence more powerful than supportive, because many of the contending drivers are roughly, but not exactly, collinear. More detailed examination would make use of what we know empirically about the time scale of effects following causes in travel behaviour – well documented in some variables e.g. transport prices, income: a long-term impact cannot happen in the same year as a change in driver, for example, but spread over some years after.	This test is more powerful at the less aggregate level, e.g. for specific cities, types of area, policy initiatives, categories of people – since there will be a wider range of timing experience, and hence more likelihood of picking up counter-hypothesis evidence**.**
Income	(a) Evidence of change in income elasticity over time (b) Evidence of changing car use of different income groups, particularly the highest and lowest (c) Locations with growing income compared with locations with declining income	a) S and PC suggest that elasticity of car use with income has declined towards, or to zero; IG sees continued substantial positive income elasticity as important driver. b) IG would indicate rich to show stable or increasing car use, poor to show (temporary) reductions. S might indicate more even responses (income being less important than relative status). PC might see opposite impact as richer have more potential to lead a new trend. c) IG would indicate locations with growing income to show more traffic growth than those with declining income. S and PC have not suggested a particular pattern – the test is more suggestive for/against IG.	(a) There are good published aggregate econometric studies on this, but less at household level over time. (b) Note that strictly test should relate to people with g*rowing* and *falling* income rather than high and low. However during a time of widening income distribution this will be a characteristic of the highest and lowest groups. (Also because of the dispersive part of regression to mean processes). So test on highest and lowest will be broadly valid.
Population	Is traffic growth proportional (less, more) to population growth?	IG has suggested nearly proportional. S has suggested strong dependence on brownfield/greenfield balance. PC would also imply this, but with stronger effect.	May be more useful to use *density* rather than population – NTS allows this
Congestion	Does rising congestion damp further traffic growth?	Historically, IG has put much emphasis on congestion effects, but currently the proposition is that effect is not strong enough to offset other effects. S sees it as a contribution to saturation. PC sees it as a possible divergent effect (see below).	Difficult to test because of inherent two-way effect – all agree that rising traffic increases congestion. Useful to explore but may not usefully discriminate.

LONG-RUN TRENDS IN CAR USE © OECD/ITF 2013

Table 3. (continued) **Tests of evidence tending to discriminate among the three hypotheses, IG (Interrupted Growth); S (Saturation); PC (Peak Car)**

Phenomenon	Nature of Test	Inference	Notes
Other policies	Do other policies significantly affect traffic growth and levels? The two most discussed have been reallocation of road capacity and "smarter choices" (soft) initiatives.	All approaches accept there must be some effect, but IG has tended to say effect must be small or very small compared with population, fuel price and income, S has not depended on them either way, and PC has tended to say effects are large.	A great deal of evidence at the town/city level, because that is the level where policies have differed. Research would initially be revisiting and reviewing the published studies. (Note that an essential feature of any approach stating that selected variables are a "sufficient" explanation is the presumption that other variables, which may be collinear, are unimportant.) There is an active discussion on this, with detailed evidence already cited.
Non transport drivers	Are there apparent other major social/economic changes which have appreciable effects on travel choices?	IG has tended to say no, but if they exist will be reflected in model parameters. S has not depended on these. PC has tended to suggest social attitudes (health, environment, status) and technical changes, especially mobile computing. There are also other big social changes which might have an effect (e.g. gender changes, households, culture) but which are not *a priori* associated with one hypothesis or another.	Tests might be detecting particular groups who seem more influenced by these drivers, and seeing whether there is evidence that their travel choices differ. This would be exploratory rather than clear hypothesis testing (but no less useful in the longer run).
Equilibrating/damping processes	What do the hypotheses imply about robustness and reliability of their forecasts?	S sees achievement of a saturation level as an equilibrium and stable position. IG and PC are divergent – they get further apart over time, possibly reinforced by the policies each might adopt – i.e. S has more negative feedback, IG and PC might have more positive feedback. There are strong (but complex, and sometimes counter-intuitive) implications for robustness, processes of policy and project appraisal, and for strategic policy development.	Not clear that this can be tested empirically, but it is an essential part of the discussion about what policy conclusions might follow from each.

7. Some future policy issues

(Note: this section is drafted mostly with reference to policy discussions in the UK, each country having its own specific cultural and political constraints on the way policy is discussed and determined. But it may be that the underlying principles are common to other countries also.)

7.1 Robustness to uncertain futures

There have been many years, in some countries decades, of assuming that forecasts of future mobility are about as well determined as forecasts of the future economic variables which determine them. In this case there will be an envelope of uncertainty of travel forecasts, but it is quite likely to be a rather narrow envelope.

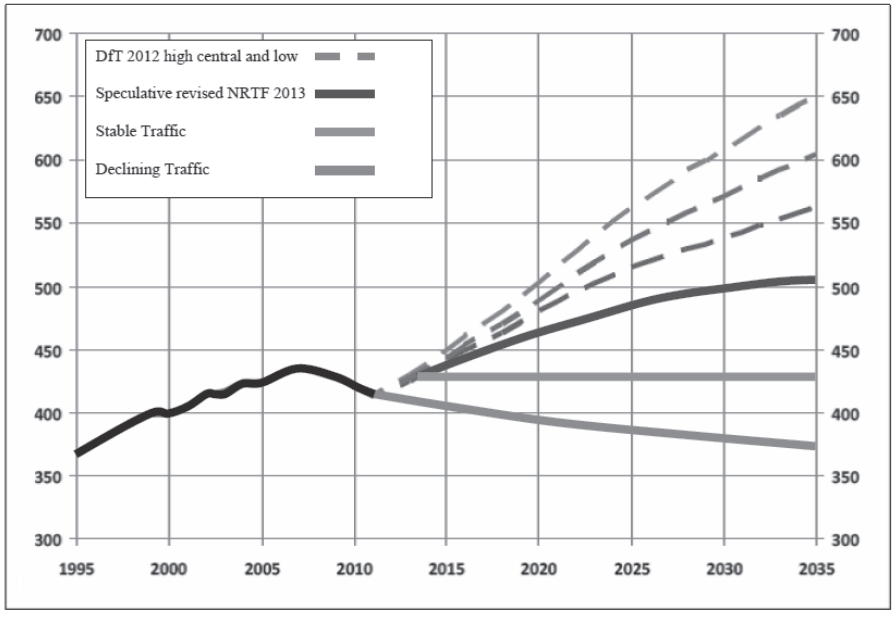
However, the situation now seems rather different. There is uncertainty of a different type, namely about the underlying relationships themselves, and it cannot be assumed that there is only one viable forecast of travel corresponding with any particular assumption of, say, economic growth or fuel prices. In that case, it is logically necessary consider the robustness of future policies and projects in terms of scenarios about the future, not forecasts of it. This will remain true until the big research issues about future mobility are resolved to the point of a reasonable degree of consensus, which does not yet exist. The policy issue is of appraisal under conditions of contested futures.

An example of such an approach is shown in Figure 18 in relation to UK conditions (though somewhat similar arguments could apply to many countries) by comparing the DfT's National Transport Model's outputs – a trajectory of aggregate traffic volumes year by year into the future – but reflecting the range of futures which now start to become credible. As a grey background three dotted lines are DfT's current (2012) assumptions about three futures for England – a "high demand", "low demand" and "central" projection, which differ (but not by very much) in relation to Government publicly expressed assumptions about economic growth, oil prices and fuel economy. The three coloured lines, however, are not simply an exploration of a wider range of possible scenarios, but are based on different interpretations of the evidence about the peak discussions. The red line, an expected return to growth (though less than previously forecast), is likely to be one where some road capacity expansion, though less necessary or good value for money in CBA terms, might actually start to become more useful in "making things better" rather than "slowing down the pace at which they get worse".

The blue line is simply a stable level of traffic continued at a suitably defined "current" level, somewhat increased to close to its 2005 peak. This is a simplified version of the idea of traffic saturation, ignoring the critical conversion from per capita saturation to population totals, which depends on the physical location of housing development, so itself requires a high and low envelope. For the scenario, simply choosing a stable volume of traffic has one decisive appraisal advantage: it unambiguously addresses the question "what would this policy or project do for the current problems that we see and experience"? It therefore does not depend on the elusive concept of "better than it otherwise would have been": it just relies on "better". For public discussion this represents a robust

and transparent idea with no trickery. (A reminder: this is about "base" demand, and it would still be necessary, as in all the scenarios, to calculate induced traffic).

Figure 18. **Suggested increasing, stable and reducing traffic scenarios for appraisal**



The green line approximately reflects, but simplifies, the idea that the stabilisation then traffic decline in recent years may be in part a structural change in trends, influenced by mobile computing, demographics, cultural expectations, costs and policy. For forecasts, this approach itself would need two branches, depending on whether the associated policies have a positive feedback effect ("virtuous circle") increasing the rate of decline, at least for a period, or a damping effect leading to a new, but lower, saturation level. That is, probably, too complicated to deal with for a scenario, but the simpler version shown, with a reduction of about 0.5% a year back to around the 1995 level, also makes a genuine contribution to understanding even in advance of confidence at the forecasting level. This is because it represents downside risk of expensive investments being unremunerated, in money or benefit, hence is crucial for negotiating risk as between the public and private sector, and testing the robustness of both capacity and demand management to different futures.

There will, of course, only be one future which actually happens, but we do not yet know what it is. In the meantime the three scenarios illuminate appraisal while not needing agreement on forecasts, only requiring a shared respect for the legitimacy of views that traffic could, possibly, increase, stay stable, or reduce.

Thus the essence of policy appraisal would shift. A key question – to be applied to major strategic trajectories and also to large scale specific projects, would be: does this policy stay a "good thing" under all the contending scenarios, or does it only make sense under one of them? This tackles the question of robustness, and helps positive decisions to be taken even before consensus is reached on the research.

A more ambitious approach would be to assign probabilities to the different scenarios, though in one sense that simply displaces the problem: if we were in a position to establish consensus probabilities, we would also be in a position where there was more agreement about the interpretation of the evidence than has yet been reached. Even so, there is an advantage in separating the established facts from the contested judgements, which would assist transparency in decision making.

7.2 A specific policy issue: the allocation of risk in the case of private investment into major transport infrastructure projects supported by public policy

An issue of interest in many countries is whether private funding sources can be found to finance major infrastructure projects which are desired by public policy. In the UK this takes the form of encouragement by the UK Treasury for bodies such as pension funds to encourage them to invest in the country's infrastructure.

However, pension funds – indeed, any private investment whether on behalf of pensioners, shareholders, or trust beneficiaries – have legal obligations to spend their stakeholders' money on sound financial principles. If they do not do so, their decisions can be challenged not just in political hurly-burley, but in the courts, with real money at stake. As with a share flotation, the key issue will be the Prospectus, the formal analysis of an offer which has sound expectations of financial return, and careful consideration of risks, especially downside risks – what are the chances of a worse return than expected, and who bears the risk if so? The prospectus methodologies may (or may not) be the same as those used for public sector forecasts, but the application, responsibility for error, focus, authority and implied power are different. In other words, due diligence means that some independent consideration of the validity of official forecasts is certain to happen, in one form or another, and with legal consequences.

The first thing such a review will need to do is consider the track record of the currently authorised forecasting procedures. They are not uniformly good. Then one can consider a role-playing game. Suppose you are the investment manager for XYZ Pension Fund, considering whether to invest in the M999 bridge and motorway widening programme, vitally necessary, you are told, because it is already operating to capacity and the traffic will increase by 50% over the next 25 years. This sounds like a good prospect, and the question arises about whether to opt for a real charging scheme, taking in an income stream from many individual motorists, or a shadow scheme, paid by the Government in relation to future traffic. So you look at the forecasts, and the forecasting record. Now the graph indicates a downside risk of the long term traffic flows being substantially less than the forecasts, as they have continually been for at least the last quarter of a century. In that case, an income depending on real charged prices is going to be less profitable than an income stream guaranteed by the Government based on the Government's own forecasts. So the investor will ask for a guarantee. But the downside risk for Government would be the danger of paying a lot of money, not underpinned by buoyant tax revenue, in respect of traffic flows which under-perform, for a project which for that reason turns out to be a lot less necessary anyway.

But consider the opposite outcome: suppose that the traffic forecasts do turn out to be accurate, or even underestimates. Then the cash flows are more robust but there is a danger of significant reputational damage, since congestion will actually be getting worse, not better, and the investing agency will be taking a substantial, highly visible, controversial income, in respect of a worsening quality of service.

These twin fault-lines – financial risk if the forecasts are overestimates, and reputational damage if they are correct or underestimates – suggest, it seems to me, that the ideas will evolve over the

period of negotiation to one of two pro-active forms. First, it could be a real road pricing scheme with a much greater public, rather than private, focus, for the traditional reasons of tax revenue and travel demand management, rather than road expansion. The second possibility would be to evolve into more and more extravagant guarantees, ending in a PFI-like scheme which risks paying substantially too much to the private providers. Both options are currently very unattractive politically. So a third, passive scenario could then emerge, suggesting that, since traffic is rather stable, maybe it is better just to let the issue lie for a while, while focussing on other improvements such as maintenance

7.3 Another example of policy implications: "smart" methods aimed at reducing car use

The main reason for the growth of implementation and experience on smarter choices (then called "soft measures") in the late 1990s and early 2000s, culminating in their breakthrough into the policy mainstream after 2004, was because they offered a (relatively) easy, cheap and politically attractive way of reducing the expected traffic growth to levels which were compatible with the amount of road capacity which was or could be made available. The main alternative approaches – a massive road building programme big enough to outpace forecast traffic growth, or system-wide road pricing to ensure economically efficient use of road capacity – each had their persistent champions, but neither ever came close top commanding majority support in the population in the UK. Opinion polls suggested a stable support level for either of around 30%, with at least as many vigorously opposing. Politically neither added up. By contrast, smarter choices had no natural opposition of any substance, and a lot of gentle goodwill, often up to 80-90%.

Currently there are great financial pressures on national and local government, as indeed on most of the public, and there is a need for reassurance that any substantial expenditure gives good value for money, and is in accord with the political and economic priorities of the time. There is substantial evidence that smarter choices give very good value for money indeed – better than most infrastructure projects – in line with a decade of discovery that small, local, cheap improvements to the quality and ease of transport (such as local safety schemes, area traffic management, reallocation of road capacity to walkers, cyclists and public transport, and improvements to the public realm in town centres and areas of concentrated shopping and leisure activity) typically give benefit cost ratios (BCRs) in double figures, with benefits that may be 10 or 20 times as large as costs, or more, compared with ratios in the range 1-6 of even the best infrastructure projects. It is true, however, that not everybody fully understands these results, and some even casually reject them. There is genuinely a need for refreshing the knowledge base and understanding of the great measured benefits, and the very positive political goodwill, which smarter choices bring.

In this context, there is great significance in the observation that in recent years traffic levels, and especially car use, has simply not grown as much as was being forecast from the late 1980s onwards. As discussed above, there is a lively debate about the reasons for this, with broadly two different views. The "official" view is that the phenomenon is essentially temporary, due to economic conditions, with the expectation that when the economy returns to "normal" functioning, so also will traffic growth. The alternative explanations suggest that the phenomenon preceded the current economic difficulties and therefore should not be attributed to them: rather, there are signs of a structural shift in attitudes to cars and the resulting travel choices, so the future will show a long-lasting stable level of car use, or even falls. Indeed, the previous implementation of policies intended to reduce car use, may have actually succeeded in doing so, and the policies have turned out more successful than is often thought. The question is – what effect does this unresolved debate have on the usefulness of further implementation of the same policies?

If the official view is right, then smarter choices will remain as an essential set of instruments of policy to cope with traffic growth which cannot be solved by other politically acceptable or affordable methods. If the alternative view is right, however, then the argument is not exactly symmetrical: if people are using cars less this does not of itself solve all the problems of mobility and access, and there will need to be a much wider application of other methods to assist people with efficient and high quality transport systems. Then, it seems likely that the balance among the different smarter choice methods is likely to shift, as "dealing with excessive traffic" becomes less of an issue but "providing good mobility solutions by means other than car use" is by no means less important.

The result of this seems to me to be that one needs a short-term smarter choices strategy which is suitable for either of the outcomes, but then with the expectation that it will be fine-tuned in different ways according to whether the official, or alternative, view turns out to be right. That is an excellent example of a robust and flexible policy.

This is an important example of interaction between research and policy, with a conflict shown in a deeply-rooted, and long-lasting, incompatibility between two arms of government, or two mind-sets of understanding, which give conflicting signals and threaten to weaken – or, at worst, paralyse – a most constructive and worthwhile instrument of policy.

One the one hand, smarter choices, formerly called "soft measures" provide a general but profound set of influences on travel behaviour, empirically demonstrated time and time again as able to alter choices with little or no opposition, no natural opposition, little offense, and excellent value for money. On the other hand, they provide a continual challenge to analytical orthodoxy. They do not fit easily into the longest-established set of forecasting tools, challenging either their behavioural assumptions or formal specification. Their benefits seem not to sit comfortably alongside the traditional ones of time and money saving. If the empirical results are taken at face value, they raise uncomfortable questions of whether the well-established modelling frameworks are as good as is claimed for them, and therefore raise questions about other policies also.

Notes

1. Not everybody is comfortable with the phrase, which is drawn from an analogy with "peak oil", because the correspondence is not exact in terms of physical limits or the nature of production costs. Nevertheless, it expresses a hypothesis very succinctly and there is not another short label offered.

2. The evidence that car use is different according to whether population growth is accommodated in dense urban areas, suburbs or rural areas seems to be very strong, and presumptions of proportionality to population are therefore very vulnerable.

3. The author has noticed that early discussion of a stable average travel time budget was often expressed as a stable 55 minutes, later a stable 60 minutes, and recently a stable 1.1 hours.

4. This can be seen in a particularly vivid "moving pictures" format on his website at: www.gordonstokes.co.uk/transport/peakcar.html

5. This is sometimes described as "an increase in car use among older drivers". That is misleading: they have not been increasing their car use, but driving more than previous generations of old people, which is an important distinction.

6. There is a curious dissonance between the quantitative models embodying this concept and the ideological, cultural and environmental presumptions which would, when made explicit, generally be found quite distasteful, and probably incompatible with respectable world views.

7. Stokes (2012) later wrote that this seemed to them so unlikely that they left it out of their subsequent work on the subject.

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Chapter 3

Have Americans Hit Peak Travel?

A discussion of the changes in US driving habits

Robert Puentes[4]

Abstract

After decades of increases, the growth in driving in the United States is levelling off, and dropping on a per capita basis. These shifts have enormous implications for public policy in the US and abroad, as evidence shows that this phenomenon is generally reflected in developed counties around the world with mature transportation systems. Yet while there is little doubt that the sputtering US economy has a major impact, emerging research suggests the changes in driving habits also result from a long-term structural change, reflective of a host of shifts in demographics, culture, technology, as well as settlement patterns in US metropolitan areas. But whether due to a momentary blip or long-term structural changes, the changes have important implications for public policy. For example, US roadways are arguably safer and less congested. However, the resulting declines in gasoline consumption also result in less revenue collected from gasoline taxes and fewer resources for all modes, including public transport. The key is for policymakers to understand these new developments and their impacts on transportation finance, the environment, and general economic development. This paper explores those macro forces through an analysis of driving trends, a review of existing literature and a discussion of what is likely behind these trends, as well as implications for public policy.

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1. Introduction

American driving habits are changing. After decades of steady increases, the growth in driving is clearly levelling off, and dropping on a per capita basis, even at a time when a vast array of public policies continue to support and encourage driving. Perhaps even more amazing are total aggregate declines in some recent years coupled with drops in licensing, trips and vehicle purchases. These shifts have enormous implications for public policy in the US. Ample evidence shows that this phenomenon is not limited to the US, but is generally reflected in other developed countries around the world with mature transportation systems.

However, this phenomenon is still not well known. When they are recognised, these individual trends are largely dismissed as economic factors caused by the global recession and a stubbornly high unemployment rate. While there is little doubt that the sputtering US economy has a major impact, emerging research suggests the changes in US driving habits are also the result of a long-term structural change, reflecting a host of shifts in demographics, culture and technology, as well as settlement patterns in US metropolitan areas. A set of public policies also plays a key role.

This paper explores those macro forces through an analysis of driving trends, a review of existing literature and a discussion of what is probably behind these trends, as well as implications for public policy[1].

2. Background and key American driving trends

In 2008, for the first time in human history, the majority of the world's inhabitants lived in urban and metropolitan areas. In the United States, the 100 largest metropolitan areas constitute two-thirds of the national population and account for fully three-quarters of US GDP. This represents a fundamental and dramatic shift and is only expected to intensify. The impacts on the global economy, our social networks and the built environment will be dramatic and are likely to transform the very fabric of human life.

In the US, this conversion is affected by several factors:

Our national economy is in the midst of broad and **intensive restructuring**. This is partially unintentional and precipitated by the most severe economic crisis in more than a generation. The reverberations from the Great Recession are still strongly felt. In response, major attention is being given to moving away from the over-leveraged, debt-driven economy that preceded the recession to one focused on globalisation, technological innovation and production, rather than consumption[2].

At the same time, the US is undergoing the most remarkable **socio-demographic changes** it has seen in nearly a century. The number of seniors and boomers already exceeds 100 million, and racial and ethnic minorities accounted for 83% of our population growth this last decade. But, unlike our international counterparts in Europe and parts of Asia, the US is also growing rapidly overall. Our population exceeded 300 million in 2006 and we remain on track to hit 350 million in the next 15 years[3].

Cities and large **metropolitan areas are leading this transformation** and will, in many ways, determine the path forward. America's 100 largest metropolises already account for two-thirds of our population and generate 75% of our Gross Domestic Product. What is more, most of the future growth of the US is expected to occur in these places. About 60% of future residential growth will be in just the fifty largest metropolitan areas[4].

How these trends are playing out carries far-reaching implications for transportation, especially in light of significant new constraints at the intersection between place and the economy.

One implication is the imperative of lower carbon. The world economy is rapidly moving away from carbon-based fuels and towards new sources of energy, driven in part by state, national and international goals and agreements. Narrow discussions of the impacts of cap and trade regimes or of green jobs have obscured how profound and market-driving a transition this will be (similar to the transformative effect of the internet). Shifting to new energy sources will affect the types of vehicles produced, the types of homes built, the shape and location of communities and how we get from one place to another.

Another implication is the nation's current fiscal situation. With horrendous budget conditions on the federal, state and local levels and several years of national economic uncertainty, a tense new climate of austerity has sharpened debates over government spending, economic development and the physical growth of states and metropolitan areas. Leaders in this environment are eager for fiscally prudent ways to simultaneously support their communities, stimulate their economies and operate more efficiently. This impacts everything from tax policy to business subsidies, as well as transportation and infrastructure spending.

The US is also facing unprecedented constraints when it comes to its natural resources. Driven by cheap land, abundant water and low-cost energy, American growth patterns over the last several decades followed the same sprawling, consumption-oriented style as our national economy. Accommodating future growth will require a long-time partnership of all relevant actors – public, private and non-profit – to design the kinds of accessible and sustainable communities the market is increasingly demanding.

The confluence of these macro factors certainly impacts overall driving levels. However, these effects are extraordinarily complex, and broad agreement does not exist with respect to the nature of the relationship. Nevertheless, we can observe several major trends with respect to American driving habits that represent a significant departure from prior decades.

First, after decades of steady growth, driving in the US has levelled off and is dropping relative to the population.

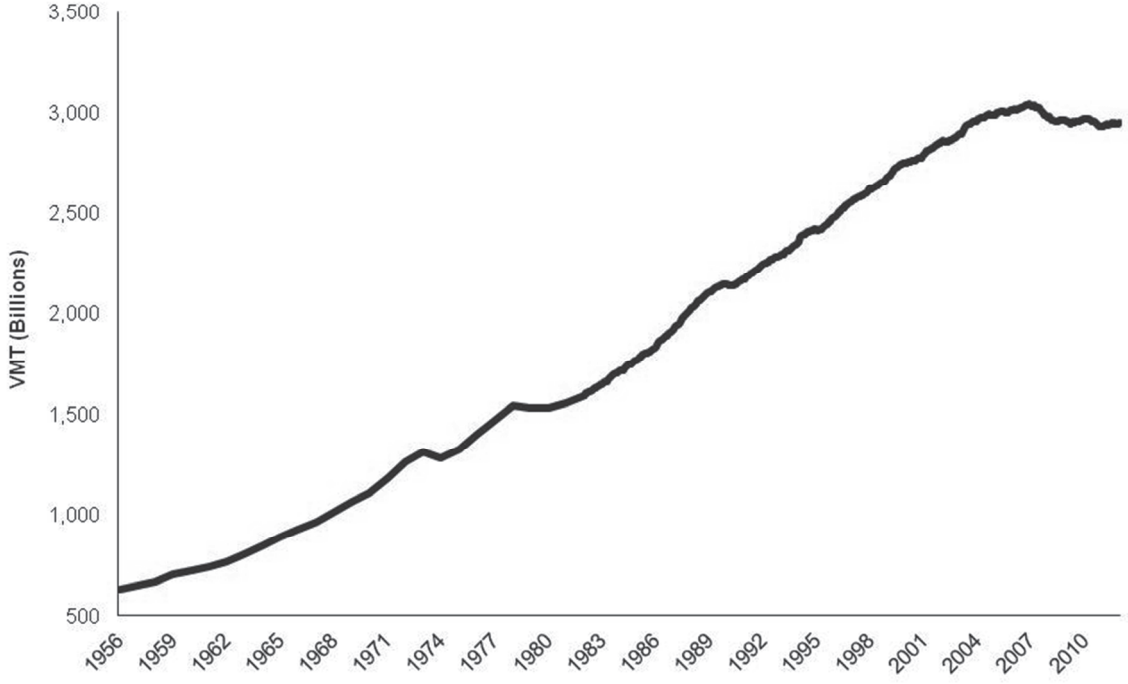
Vehicle miles travelled (VMT) is a straightforward statistic used to measure the demand for driving in the US, since it is collected at the national level, reported regularly and is easy to understand. This figure includes all drivers, roads and vehicle types (i.e. whether for passengers or freight, or public or private purposes). Not only does it provide important data on the use of an

individual piece of roadway, but aggregated up – to metropolitan, state or national levels – it also shapes the transportation planning and programming of billions of public dollars.

Total driving in the US hit its peak in 2007, when Americans logged over three trillion VMT. Since then, there has been no growth in driving in the US. In fact, the latest data through early 2012 indicates an annualised drop of over 93 million miles since the peak. The average annual change since 2007 is -0.03%, at a time when the average change in population is 0.07%.

As Figure 1 illustrates, the drop in total driving is a remarkable trend historically since, for nearly every single year since the statistics were collected, overall driving always increased. Sometimes dramatically so, such as the 5.3% change from 1987 to 1988, or the 6.8% jump from 1971 to 1972. The last increase of over 1% was from 2003 to 2004, and the overall drop in 2007 was the first since a slight decline in the early 1990s and only the fourth time since World War II. In short, we are currently witnessing the largest sustained drop in driving in American history.

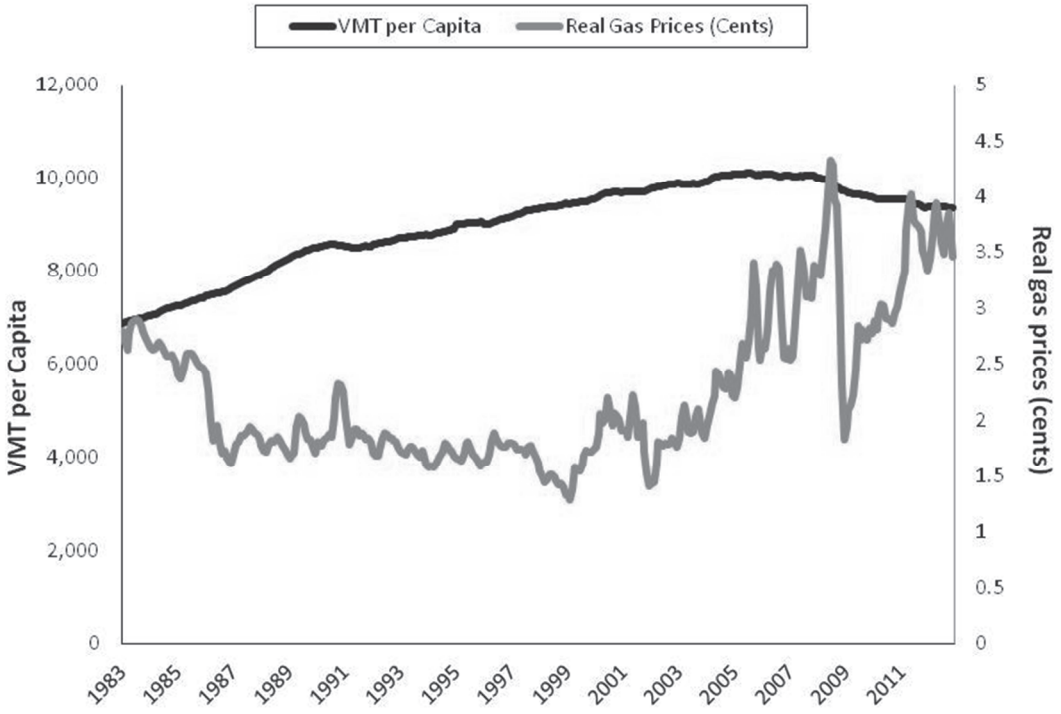
Figure 1. **US vehicle miles travelled, annualised, December 1956-November 2012**



Sources: 1956-1982: *Highway Statistics,* Table VM-201*;*
1983-November 2012: *Traffic Volume Trends.*

The overall declines are noteworthy but comparing overall driving to population growth indicates that the slowdown in VMT growth actually began as early as 2000. Figure 2 shows that the VMT per capita rate in November 2012 was about the same as in 1999, with an overall downward trajectory ever since. It is interesting to note that the years of slow or negative growth do not always coincide with increases in fuel (gasoline) prices, as discussed below.

Figure 2. **US vehicle miles travelled per capita, annualised and real gasoline pump prices, January 1991-November 2012**

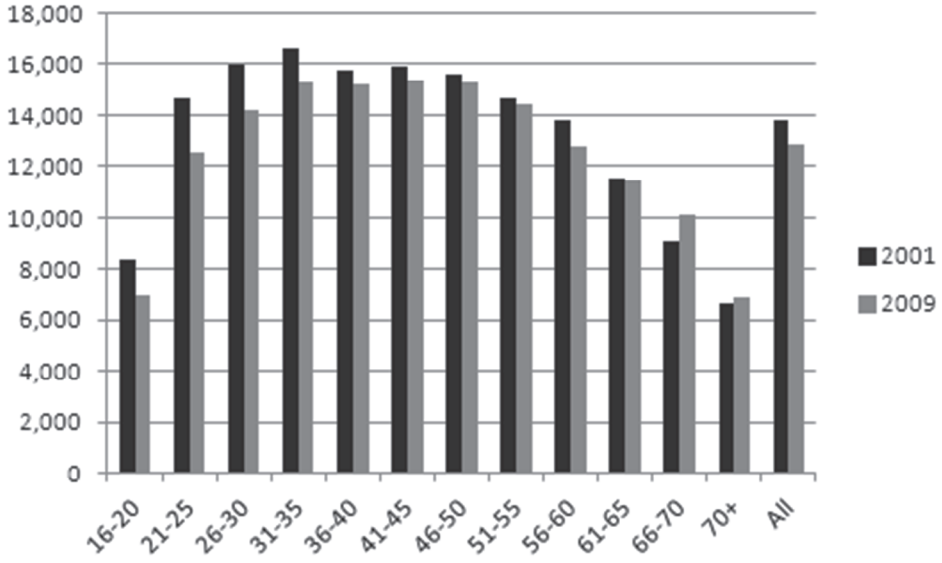


Source: Traffic Volume Trends and Energy Information Administration.

While the aggregate and per capita numbers described above are for total VMT, for the purposes of this analysis it is important to look at the types of vehicles to better understand the possible purpose of those trips; for example, to determine if the overall declines in VMT are attributable to drops in freight traffic. Indeed, since 2007, passenger vehicles saw a smaller drop overall (-1.8%) than trucks (-5.8%)[1]. However, since the vast majority of VMT was generated by passenger vehicles (89.9% in 2010), the overall trends are largely the result of changes in passenger vehicles. (It is important to note that truck VMT increased from 7.5% in 2000 to 9.7% in 2010.)

As discussed later, Baxandall, David and Dutzik (2012) show that from 2001 to 2009, the annual number of vehicle miles travelled by young people (16 to 34-year-olds) decreased by 23%, from 10 300 to 7 900 miles per capita. They report that the same age group took 15% fewer trips in 2009 than 2001 and the trips they did take in a vehicle were 6% shorter. Looking only at drivers age 16-20, the amount of annual VMT fell from 8 410 in 2001 to 6 964 in 2009, a remarkable decline of 21%[2]. Figure 3 shows that the only age groups that drove more in the aggregate from 2001 to 2009 were those over the age of 65.

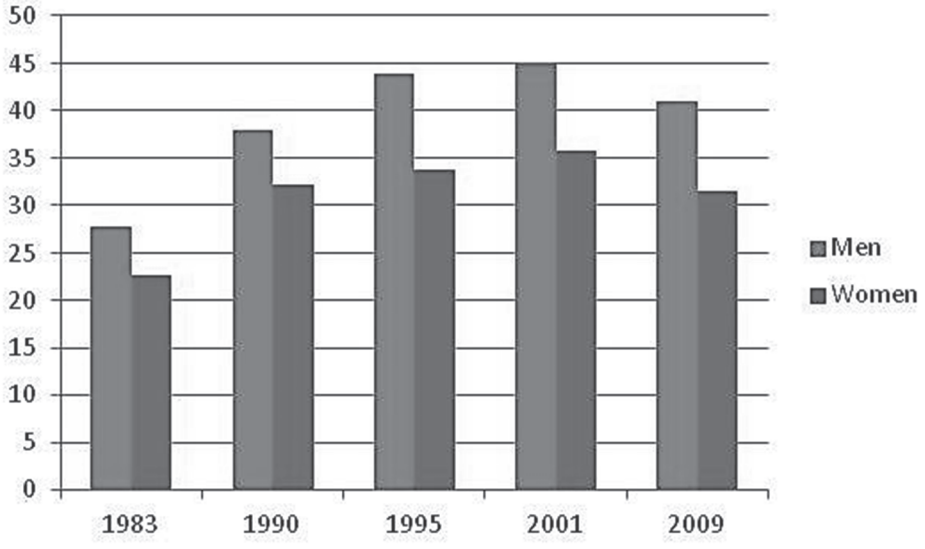
Figure 3. **Annual vehicle miles travelled/driver by age group, 2001 and 2009**



Source: Federal Highway Administration, National Household Travel Survey.

On average in the US, women take slightly more trips than men. While men report more work-related trips, women take more trips for family errands and school. However, because of the purpose of those trips, American men drive much greater distances, averaging 40.9 person-miles of travel per day. Figure 3a shows a much greater drop in miles travelled per day for men. Men aged 36-65 drove, by far, the most per day: 50.9 miles.

Figure 3a. **Person miles of travel per person by age**



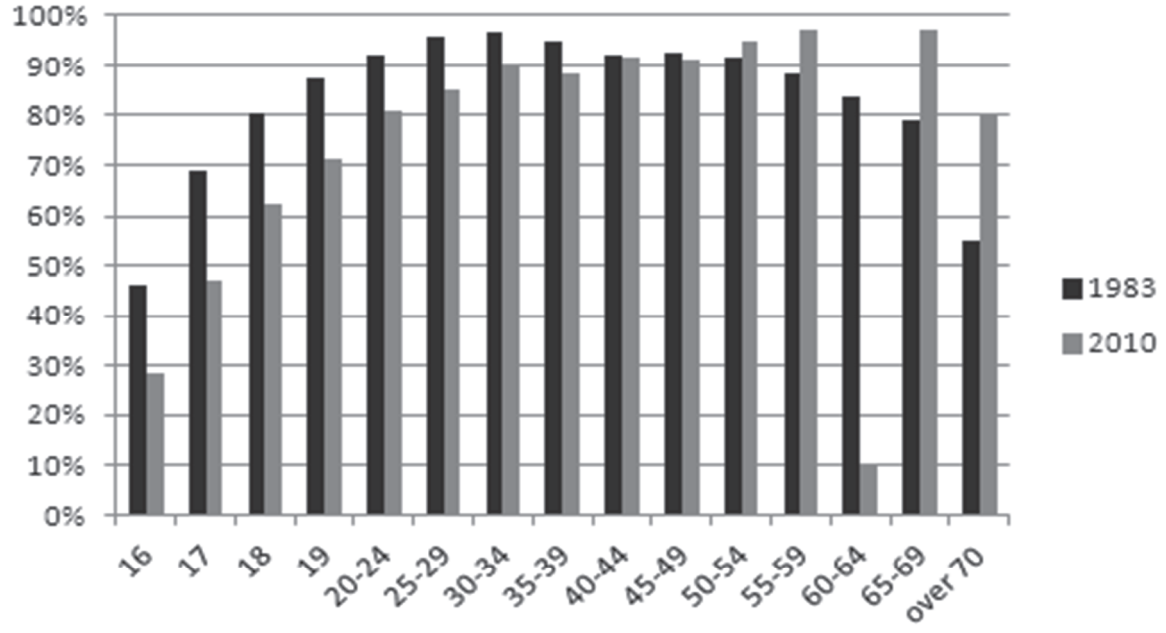
Source: Federal Highway Administration, National Household Travel Survey.

Second, the number of licensed drivers in the US is barely growing

As a growing country, the number of licensed drivers in the US continues to increase. The latest data show that over 211 million Americans had drivers' licences in 2010[3]. Yet this was only an increase of 1.7 million from 2009 though the population grew by four times that amount. The growth in drivers' licensing from 2009 to 2010 was the smallest increase since 1960[4]. About two-thirds of all Americans are licensed, which is generally the same figure since the early 1980s.

Much of the attention for drops in drivers' licensing in the US focuses on younger drivers. Indeed, since 1983 there has been a substantial reduction in the percentage of young persons with a driver's licence, from 46.2% in 1983 to 28.7% in 2010. Other teenage cohorts saw significant drops as well. Figure 4 also shows that every cohort under 50 shows a smaller percentage of the licensed population in 2010 than in 1983[5]. Sivak and Schoettle (2011) show that since the 20-44 age group in 1983 is the same as the 45-69 age group in 2010 and, as the percentage of those with a driver's licence did not change much, this suggests the same individuals remained without one.

Figure 4. **Percentage of population with a driver's licence, by age group 1983 and 2010**



Source: Federal Highway Administration*, Highway Statistics Series,* Table DL-20.

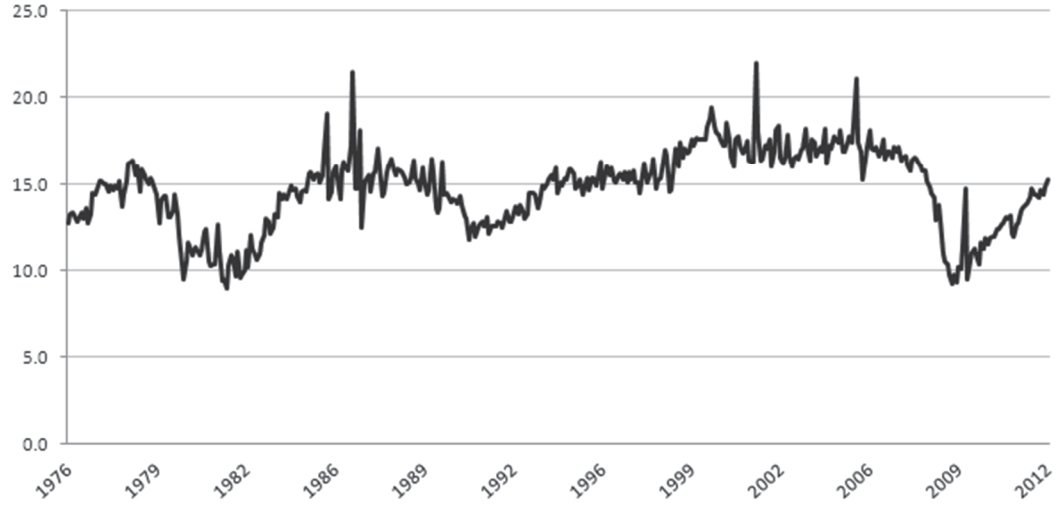
However, partially offsetting a portion of the decline in younger drivers is the aging of the "baby boom" generation. Pre-seniors (55-64) are this decade's fastest growing age group, expanding by an amazing 50% in size from 2000 to 2010 with a "senior tsunami" predicted to arrive soon thereafter. The portion of the population over the age of 65, now at 12.6%, will increase dramatically in the coming decades. While media and political attention to this massive shift in age distribution has focused on its impact on social security and Medicare, the aging of America also will lead to significant changes in travel demand and the physical form of metropolitan areas.

For example, there were 22 million US drivers over the age of 70 in 2010, compared to only 10 million in 1983[6]: (by comparison, there were only 10 million drivers under 19 in 2010, compared to 11 million in 1983). However, as discussed above, while there are more elderly drivers, data from 2009 show that they drove about the same (6 890 annual VMT) as drivers aged 16-20 (6 964 annual VMT). Other research shows that drivers with reported physical impairments (e.g. memory, vision, arthritis) will "self-limit their driving by making fewer trips [and] travelling shorter distances (Braitman and McCartt, 2008)."

Third, for the first time in a generation, the total number of vehicles on the road in the US recently dropped, although new car sales have recently picked up.

After steadily increasing every year since the end of WWII, the total number of registered vehicles in the US declined in 2011, the most recent year for which federal data is available. The number of registered light-duty vehicles (passenger cars, light trucks and SUVs) fell from an all-time high of 236 million in 2009 to 234 million a year later. Only the number of registered motorcycles has continued to rise. More recent data from the Bureau of Economic Analysis on new passenger vehicle purchases shows a sharp decline beginning in late 2007 that did not begin to recover until the middle of 2009 (Figure 5). Sales increased steadily since then but only up to 2008 levels, and still far short of the peak in July 2005.

Figure 5. **Motor vehicle unit retail sales, autos and light trucks, seasonally adjusted at annual rates, January 1976-September 2012 (in millions)**



Source: US Bureau of Economic Analysis (BEA), from American Automobile Manufacturers Association.

Nevertheless, the total number of registered vehicles in the US rose by 14 million from 2001 to 2011, a time when the number of licensed drivers grew by 20.5 million. California and Colorado each have nearly half a million fewer registered vehicles in their states in 2011 than they did in 2001. In Ohio, there are over 720 000 less vehicles. Fast-growing states like North Carolina, Oregon and Tennessee also have fewer registered vehicles.

A recent report highlights stagnant demand in the US automobile market, noting that there are 5 million fewer car buyers today than five years prior[7]. The report predicts the success of "mega-producers", whose production levels will double by 2017 and will account for the major part of industry growth. According to John Hoffecker, managing director at AlixPartners, these companies must implement a global standard of production and account for varying consumer needs.

3. What is behind the changes in US driving habits?

For years, the most obvious factor contributing to growth in VMT was population growth and the increase in American drivers. More drivers meant more driving. And with population growth expected to continue, traditional transportation forecasts continue to maintain that driving will also increase (see, e.g., McClain and Pisarski, 2012). Some continue to dismiss the drops in driving and licensing as recessionary factors and – the argument goes – once the economy recovers, Americans will resume their traditional travel habits. By the same token, others argue that youth culture has changed so much that America's love affair with the car is over[8].

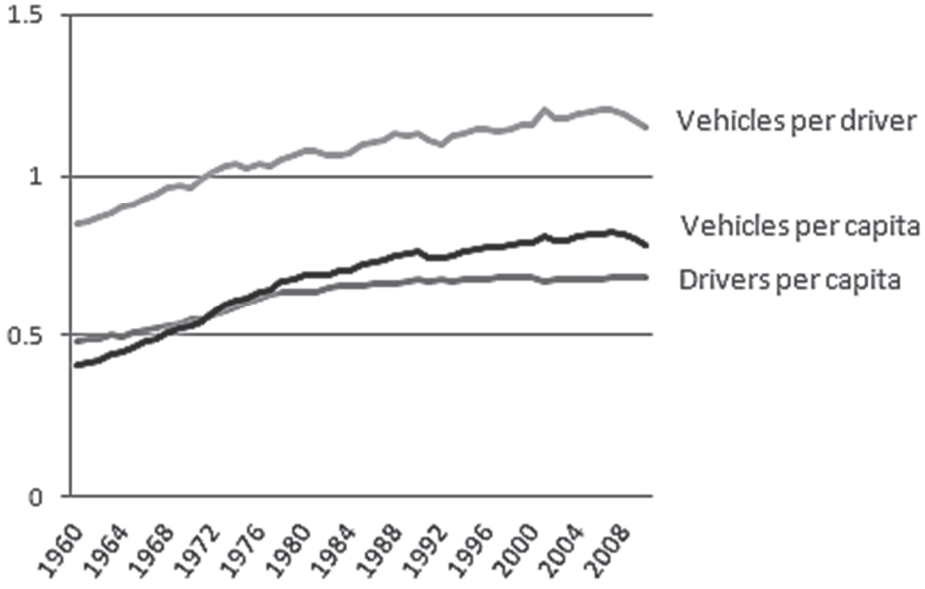
However, it is clear that the dramatic and fundamental shifts in driving habits – which essentially went unchanged for decades – is not the result of one thing. More likely is that the changes we are seeing are due to a confluence of factors, discussed below.

Several macro factors seem to suggest *structural* changes in driving habits

Several macro factors that contributed to VMT growth over the past several decades do not appear to be as relevant for the future. For example, women entering the workforce several decades ago had a significant impact on VMT that will not be repeated. In 1950, only one in three working-age women were considered part of the labour force, by the end of the century that figure rose to its peak of 60% and, overall, has remained fairly constant ever since (DiCecio, Engemann, Owyang, Wheeler, 2008.)

Related to this, the National Surface Transportation Policy and Revenue Study Commission (2008) pointed out that vehicle ownership, which contributes to VMT growth, cannot get much higher because "there is near-saturation of vehicle availability for the able-bodied adult population" (Figure 6). Since fleet turnover occurs every decade or so, new vehicle production and purchases will undoubtedly continue, but the overall scale of the impact is likely to be relatively modest concerning the number of vehicle miles travelled.

Figure 6. **Comparison of vehicles and drivers per capita, 1960-2010**



Source: Federal Highway Administration*, Highway Statistics Series.*

Others suggest that there simply may be a ceiling on the amount of driving that Americans are capable of, especially on an individual basis (for example, see discussion in Barnes, 2001). The theory is based on the concept of "Marchetti's Constant", which suggests that all people have a maximum amount of travel they wish to conduct during the course of each day and that analyses of relatively constant travel times indicate we have reached the maximum travel budgets (Marchetti, 1994). In a comprehensive look at American travel behaviour, Polzin (2006) points out that, while travel times (and therefore travel budgets) in the US have increased, *additional* increases at high rates are unlikely in the future since people will only dedicate a certain amount of time to driving. Nevertheless, Polzin (2006) points out that the link between travel time budget and VMT growth are not yet fully understood.

There are also a number of changes in consumer *preferences* for mode and housing choice

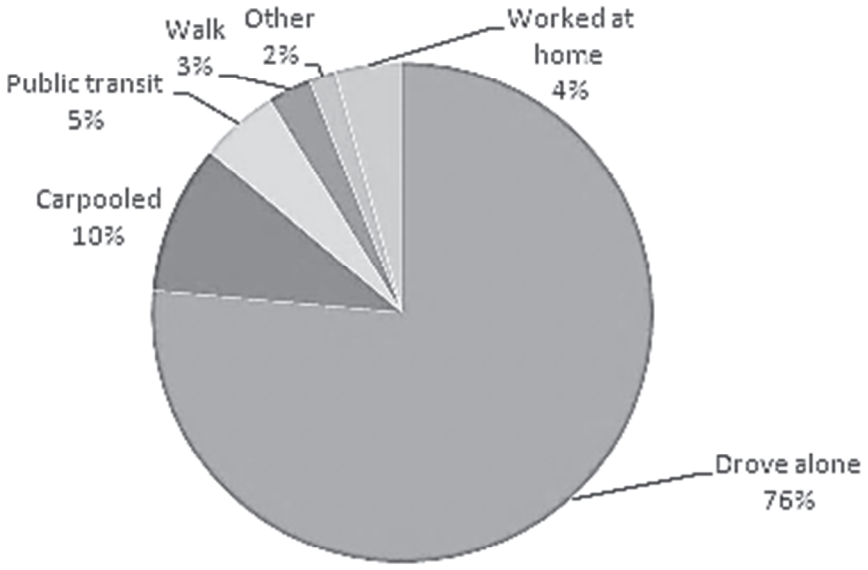
One of the interesting facts associated with the drops in US driving is the increase in so-called alternative modes, such as public transit and non-motorised modes like biking and walking. While we do not know for certain that Americans are shifting from one mode (driving) to another, the data does suggest that might be occurring to some degree.

The ridership for all modes of public transit in the US increased by 32.3% from 1995 to 2011, doubling the growth rate in population during that time (16.8%)[9]. More than three-quarters of the increase in ridership came from increases in rail transit, especially heavy rail (subways). Bus ridership rose by only 6.7% during that time.

Public transit ridership grew at about the same rate as population from 2001 to 2011 (9.5% and 9.2%, respectively) with strong increases in rail ridership (31%). However, bus ridership declined by

about 418 000 passengers, a drop of 7.3%. Further, the latest data from the American Community Survey shows that, from 2010 to 2011, commuting habits remained largely unchanged (Figure 7). However, the commuting data covers only about one-quarter of all trips.

Figure 7. **Commuting characteristic: Mode to work, 2011**



Source: American Community Survey, 2012.

Another study by Pucher and Buehler (2011) found that the average American made 17 more walk trips (for any purpose) in 2009 than in 2001. They calculated the additional distance as nine more walking miles each year. Still, the US Centers for Disease Control and Prevention (2012) found that in 2010 only 62% of Americans reported that they walked at least 10 minutes over the course of one week. This figure is up from 55.7% in 2005. The figures are generally consistent across all age groups, except for those over 65. There are some stark differences, however; such as the low walking figures among non-Hispanic blacks (about 55% in 2010) and high figures for college graduates (71%.)

Baxandall, David and Dutzik (2012) found that, while young people are travelling less by car they are increasingly using alternative transportation means, including biking, walking and public transit. In 2009, Generation Y took 24% more bike trips, walked 16% more and increased the number of annual public transport miles by 40%. Similarly, Lynott and Figueiredo (2011) discuss the increases in non-driving modes by the elderly.

Drops in driving are also associated with the rise of telecommunications technology such as social networking. Sivak and Schoettle (2011) inversely relate the percentage of young drivers to internet availability and hypothesise that "virtual contact (through electronic means) reduces the need for actual contact." Burwell (2012) reaches a similar conclusion and postulates that internet-based social networks are a more important means of interaction among young people. While it is unclear how strong the substitution factor is, a recent article in *The Economist* (2012) cited a survey by the consulting firm, TNS, that found social media were more important than cars for personal interaction.

The same article also cites a study by KCR that found that young Americans do consider online socialising to be "a substitute for some car trips".

Telecommuting, telework and the possibility for reducing travel demand through the switch from physical to electronic retail commerce are also suggested as factors in the drop in car use. In an examination of the effect of telecommuting on personal transportation by Choo, Mokhtarian and Salomon (2005), telecommuting was found to have an effect on reducing travel. Through examination of the effects of telecommunicating and alternative fuels on travel demand, Rentziou, Gkritza and Souleyrette (2012) determined that increasing the percentage of telecommunications would reduce the number of short-distance trips travelled on collector roads in both urban and rural areas, as well as some longer trips and urban freeways and principal arterials. Overall, analysts do seem to agree that in the future, technology will have the greatest impact on socio-demographic and travel behaviour patterns. However, the digital divide between white and non-white households may be problematic as the information gap worsens, and this demands further study[10].

Growing demand for urban housing is another factor that may contribute to the decline of automobile use. Frey (2012) shows that the nation's core "primary cities" grew at a slightly faster rate (1.1%) than their suburbs (0.9%) between July 2010-11. Other data from the US Census show that the "downtown" populations of cities in the largest metropolitan areas grew by 13.3% from 2000 to 2010. While these areas still make up a small share of the overall metropolitan population, cities (and especially downtowns) are where public transit service is almost ubiquitous and provides potential for travel choices other than driving (Toner and Puentes, 2011). In metropolitan Washington more than half (55.8%) of new housing units constructed so far this year (through August) were in the core cities or inner ring suburbs. In metropolitan Atlanta, the figure is 59.9%[11]. These preferences may be led by young people, as Doherty and Leinberger (2010) cite a survey showing that 77% of those aged 18-35 said they plan to live in urban centres.

Increasing the overall density of an urban area clearly results in shorter vehicle trips, but density in and of itself is no guarantee of spatial efficiency (Gordon and Richardson, 1997). Los Angeles is by some measures the nation's most densely populated metropolis, due to the lack of significant differences in population density between the central city and its suburbs, and to a dearth of open space within urbanised portions of the metropolitan area. It provides an excellent and cautionary example of a densely developed yet automobile-dependent region, with prevailing land-use patterns (long blocks, wide arterial roads, strict functional separation of primary land use) that discourage walking and consequently inhibit the development of transit ridership outside the lowest socio-economic strata (Eidlin, 2005).

Nevertheless, careful urban planning, with a particular eye to factors that impact residents' willingness and ability to use alternatives to the automobile for many trips – or at least minimise the length of car trips – can be a powerful tool for reducing transportation's contributions to carbon emissions. Even in suburbs where the vast majority of commuting occurs by automobile, individuals who live near pedestrian-oriented shopping districts are more likely to walk to shops than those who live in automobile-oriented areas (Boarnet *et al.*, 2011). While the co-location of housing and shopping can reduce vehicle travel significantly, the co-location of housing and employment yields even greater reductions in driving (Cervero and Duncan, 2006).

Other shifts may be the result of restrictions or *constraints* to driving

In the US, states are primarily responsible for laws and rules that govern drivers' licensing. In 1996, just before driving began to plateau, states started approving tougher laws. In particular, states began to adopt graduated driver licensing (GDL) programs that require greater experience before new drivers are granted a full licence[12]. By the end of 2000, all but nine states had GDL laws and others have additional requirements that place restrictions on unsupervised driving (Masten, Foss and Marshall, 2011). The motivation for these laws is not so much to restrict youth driving as it is to improve safety. The Insurance Institute for Highway Safety shows that the "crash rate per mile driven for 16-19 year-olds is four times as high as the rate for drivers 20 and older[13]."

In addition to new limits when it comes to licensing, the national recession also undoubtedly poses economic restrictions on driving. When workers fall out of the labour force, they presumably cut down on their trips (since they are not commuting to work) and may cut down on discretionary trips for shopping and entertainment. Polzin, Chu and Roman (2008) show average US household savings of an estimated USD 3 500 per each relinquished vehicle. The implications of vehicle reduction were also found to have an effect on transit use. Household shifting from one to zero vehicles had a more substantial effect, and increased transit use was found in this circumstance. Yet this should not lead to the conclusion that VMT must grow in order for the economy to prosper.

Access to opportunity is a requirement of economic activity because individuals must be able to reach certain locations where their economic activities take place. If an individual's same level of mobility is achieved through other means, less driving does not have a negative effect on their economic actions. Thus, aggregated up, declining VMT for a large geographic area will not be an indication of declining economic activity. This is especially true in modern times with other substitutes for mobility, such as telecommuting and online retail. Further, issues such as energy independence and climate mitigation (goals which are made more reachable through declining VMT) also affect economic competitiveness and are important to consider. It is still too early to determine exactly how the 2008 financial crisis and its ripple effects on the national economy will affect consumer- and business-related driving levels.

However, there is no comprehensive data on this connection. We do know that the unemployment rate for young adults remains troublingly high at 23.7%, though this is down from the peak of 27.0% in 2009. As a result, the percentage of young people who are counted in the labour force fell to its lowest level since 1955[14]. Baxandall, David and Dutzik (2012) address this issue extensively and, while they acknowledge the recessionary effects, they point out that VMT was on the decline before youth unemployment spiked in 2009.

Other studies seek to draw a direct parallel between driving habits and the health of the US economy (measured by Gross Domestic Product). Pozdena (2009) found that VMT, economic activity, fossil fuel and total energy use are intimately related over time and asserts that VMT is a major contributor to economic activity. He found that the impact of a "shock" to VMT per capita had a significant effect on GDP per capita. Specifically, a 1% change in VMT/capita causes a 0.9% change in GDP in the short run (two years) and a 0.46% change in the long run (twenty years). This finding suggests that VMT reduction policies would have negative economic consequences.

A recent longitudinal study by McMullen and Eckstein (2011) used time series techniques to empirically test for causality between VMT and level of economic activity. They specifically found that in less populated areas, VMT reduction policies may limit access to economic opportunity and, because VMT in rural areas is falling at a higher rate, VMT reduction policies may be more relevant in

urban areas where they do not threaten economic growth, since they do not restrict access in the same way. The results are also shown to be time-sensitive to economic periods. For example, during economic downturns the effects of VMT on economic activity are bidirectional, while during economic upturns only economic activity caused VMT. The findings were contrary to the previous study by Pozdena (2009), which argued that VMT causes economic activity.

While more research is clearly needed, Table 1 shows a simple correlation (Pearson) between GDP and aggregate VMT and VMT per capita, broken into recent five-year increments. Interestingly, it shows near total correlation before the recession and almost none after. Burwell (2012) also discusses this "decoupling" of VMT and GDP in the US and the UK.

Table 1. **Correlation (Pearsons) of US GDP and VMT, various years**

Type	1956-2012	1956-1970	1970-1983	1983-1990	1990-1995	1996-2000	2000-2006	2007-2012
GDP – Aggregate VMT	0.9870	0.9894	0.9899	0.9865	0.9901	0.9952	0.9756	**0.1621**
GDP – VMT per Capita	0.9409	0.9863	0.9790	0.9873	0.9859	0.9859	0.9360	**-0.0230**

Source: Federal Highway Administration*, Highway Statistics Series,* and Bureau of Economic Analysis, Real Gross Domestic Product, Quantity Indexes.

The nature of US metropolitan settlement patterns means that many Americans have *no choice* but to drive

Puentes and Tomer (2008) show that 70% of Americans in the 100 largest metropolitan areas live in neighbourhoods with access to transit service of some kind. Potoglou and Kanaroglou (2006) show that the number of bus stops within walking distance from the place of residence was negatively correlated with household vehicle ownership, especially in households under 6 km (3.7 miles) from access to transportation.

These residents can presumably cut down on their discretionary driving if they choose to, such as when gasoline/fuel prices spike. Although research on the relationship between gas prices and commuting behaviour is limited, a 2008 Congressional Budget Office (CBO) examination of driving trends in a dozen metropolitan highway locations in California found that rising gas prices reduce driving on metropolitan highways adjacent to rail systems, but have little impact in those places without. Further, they found that the increase in ridership on those transit systems is just about the same as the decline in the number of vehicles on the roadways, suggesting that commuters will switch to transit if service is available that is convenient to employment destinations. The State Smart Transportation Initiative (2012), on the other hand, found only a weak correlation between VMT and gasoline prices. Another study of the Philadelphia region, by Maley and Weinberger (2009), shows that gas price fluctuations play a significant role in explaining transit ridership during the 2000s.

However, many cities and older communities have inherited a road and rail infrastructure and low-density settlement patterns where it is challenging to reduce or alter driving habits. For example, although nearly half of work commuting still originates from, or terminates in, central cities, 39% of metropolitan work trips are entirely suburban[15]. Only about one in five metropolitan jobs is located near the urban core, within three miles of the city centre. As metropolitan areas decentralise in low-density forms of development – where residential and commercial uses are kept separate – it becomes increasingly difficult to connect people to jobs and economic opportunity with public transit in a cost-effective manner. From 2002 to 2007, the amount of developed land in the US increased by

8.4%, nearly twice the rate of population growth (4.5%)[16]. Pendall, Puentes and Martin (2006) estimate that 55% of large metropolitan residents live under traditional or exclusionary zoning regimes that separate uses and/or emphasise low-density development.

Partly as a result, a well-documented "spatial mismatch" has arisen between jobs and people in metropolitan America. In some metro areas, inner-city workers are cut off from suburban labour market opportunities. In others, low- and moderate-income suburban residents spend large shares of their incomes owning and operating cars[17]. While owning a car improves chances of employment, a growing body of work quantifies the large combined impact of housing and transportation costs on households' economic bottom lines.

4. Implications for policymakers

While there are clearly major changes in American driving habits in recent years, the precise reasons for these changes remain elusive. A confluence of factors has introduced tremendous volatility into the transportation program. Yet irrespective of why these driving trends are changing, the reality is that it IS happening. What is still unanswered is whether we will revert to traditional trends once the economy is in full recovery (interrupted growth), whether we have reached the limits of driving and car ownership and the new norm is the status quo (saturation), or whether the new trends will continue, American travel habits are changing and drops will continue (peak car).

But, whether due to a momentary blip or long-term structural changes, policymakers are finding it difficult to react, perhaps because they do not exactly know or understand the cause. Nevertheless there are direct implications, particularly with respect to how billions of dollars in public funding is spent.

Safety. Traffic accidents and crashes on our nation's roadways impose a considerable financial burden on households and on metropolitan areas in general: about USD 160 billion. These costs include property damage, lost wages and medical and legal costs. Fortunately, recent analyses show that fatalities on the nation's roadways has fallen to levels not seen since the 1940s. The 32 367 deaths in 2011 is part of an overall declining trend and is 26% lower than in 2005[18]. The decline is due to a number of factors, such as strengthened seat-belts and drunk driving laws in states, but is likely also due to overall drops in the growth in driving.

Traffic congestion. Metropolitan residents in the US have struggled with the effects of traffic congestion for years. Congestion imposes physical and psychological costs and it hinders access to jobs, recreation and time with family members. At the same time, metropolitan civic and business leaders are leading the drumbeat concerning the economic effects of growing congestion, mainly due to lost time and productivity. However, the shifts in driving patterns also mean changes in traffic congestion. For example, one study shows the hours of delay wasted due to traffic congestion in very large metropolitan areas dropped from 60 hours in 2005 to 52 hours in 2011. The figure is only slightly higher than it was in 2000. Other metropolitan-sized categories saw similar drops[19]. The implication is that the changes in travel habits coincide with a drop in traffic congestion measures.

Gasoline consumption. The US transportation system is still almost entirely dependent upon petroleum-based fuels, often supplied by other countries. However, dramatic increases in fuel efficiency of the new vehicle fleet, coupled with declines in the growth in driving, mean Americans are consuming about the same amount of petroleum (about 18 000 barrels per day) than in 2000 with an overall trend to lower levels of consumption. This has direct implications for national security since the US does not come close to producing the oil it consumes: only about one-third of the crude oil consumed in the US is domestically produced; nearly twice as much is imported and the majority of that is from countries considered in danger of "state failure", based on a range of social, economic and political factors[20].

Transportation revenue. Related, then, is the issue of declining revenues for transportation programs and projects. On the federal level, transportation revenue is largely derived from proceeds generated by the tax on gasoline. However, the gas tax does not generate enough revenue to cover the costs of the federal transportation program. Part of the problem is that the tax has not been raised, even to keep pace with inflation, since 1993. And as Americans have been driving less and driving more fuel-efficient cars, they are buying less gas, so the tax is generating less revenue overall. The implication is that, on three separate occasions since September 2008, a total of USD 34.5 billion in general funds have been used to backfill the transportation account to keep it from running a negative balance. The end result is that the fuel tax is generating fewer revenues for all types of transportation improvements, including mass transit. States and metropolitan areas need to move rapidly to alternative sources of funding.

Funding allocations. The decreases in driving also have a direct impact on funding for states, cities and metropolitan areas for several reasons. One is that large amounts of federal transportation dollars – about 17% – are distributed to these entities based solely on the amount of VMT driven. Several states' formulas use a measure of VMT to parse out these dollars, as well. The implication is that this creates a perverse incentive to keep VMT high in order to receive greater shares of funding. A better federal approach would be to reward states and metropolitan areas that can demonstrate how they are achieving national priority goals that derive from drops in VMT, such as greenhouse gas and oil consumption reduction.

Road pricing paradox. Drops in the growth in driving may dim the prospects of the US transitioning to revenue based on mileage fees. A mileage fee is a direct user fee that charges drivers for miles travelled rather than fuel used, as is done now with the gas tax. A mileage fee would be unaffected by the move to more fuel-efficient vehicles but is obviously impacted as driving declines. Also potentially impacted are proposals by private investors to build toll roads as a revenue-generating investment which may result in negative ratings of toll and transportation authorities by rating agencies[21].

Planning and programming. While no comprehensive analysis of state and metropolitan plans was conducted for this analysis, it does not appear that any have been amended to reflect these changes. In other words, these long-term plans are predicated on historical trends in driving and largely anticipate substantial future increases. While these self-fulfilling decisions have been the norm in the past, agencies should re-examine them to ensure they are truly reflective of the trends. Additional roadway capacity may not be as critical as previously thought, so funding priorities should shift to addressing the enormous maintenance and operations backlog. For example, transportation planners in the Washington, DC metropolitan area recently found inaccuracies in their travel forecasts largely due to overestimating increases in driving[22].

While policymakers appear to be slow in responding to these changes, automobile manufacturers in the US clearly have recognised the long-term shifts. Major attention is now being given to the entire transportation system and the data and telecommunications deployments to facilitate integration across modes and sectors.

5. Conclusion

The realities of the 21st century mean we need not just new policies, but a different approach to building and strengthening the next American metropolises. Fortunately, we are also at a time where there are new opportunities that make this transition not only possible, but probable. The reductions in driving and the overall changes in American travel habits should be considered generally positive, given the potential for strengthening existing places, reducing greenhouse gases from transportation and, especially, increases in safety. However, impacts on transportation revenues, job access and the automotive industry complicate the discussion. The key is for policymakers to understand these new developments and their impacts on transportation finance, the environment and general economic development.

Notes

1. It is important to note that data sources for several of the trends discussed here are inconsistent, both in terms of coverage as well as years analysed. This report endeavours to use consistent figures, years and geographies where possible.

2. Bruce Katz and Jennifer Bradley (2010), "Growth Through Innovation: A Vision of the Next Economy", Brookings.

3. Alan Berube and others (2010), "State of Metropolitan America: On the Front Lines of Demographic Transformation", Brookings.

4. Alan Berube (2007), "MetroNation: How US Metropolitan Areas Fuel American Prosperity", Brookings.

1 Passenger vehicles include all light-duty vehicles (cars, light trucks, vans and sport utility vehicles) regardless of wheelbase.

2. Federal Highway Administration, *National Household Travel Survey*.

3. Federal Highway Administration, *Highway Statistics Series*, Table DL-22.

4. Federal Highway Administration, *Highway Statistics Series*, Chart DV-1C (1960 is the earliest date from which data is available).

5. Sivak and Schoettle (2012b) also show an increase in the number of older persons with a driver's licence from 1983 to 2008 in 15 other countries.

6. Federal Highway Administration, *Highway Statistics Series*, Chart DV-1C (1960 is the earliest date from which data is available).

7. AlixPartners (2012), "Lingering Low Employment Nationally, Demographic Shifts, Potential Contagion from Europe Present Big Challenges to the Auto Industry".

8. Ashley Halsey (2012), "Has the Passion Gone out of America's Fabled Love Affair with the Automobile?", *Washington Post,* May 21.

9. American Public Transportation Association, "Public Transportation Ridership Report".

10. Nancy McGuckin (2000), "Work, Automobility, and Commuting," in: *Travel Patterns of People of Color*, Federal Highway Administration.

11. Brookings analysis of US Census Building Permits Survey.

12. Insurance Institute for Highway Safety (2012), "States Could Sharply Reduce Teen Crash Deaths by Strengthening Graduated Driver Licensing Laws".

13. Insurance Institute for Highway Safety, Highway Loss Data Institute.

14. US Bureau of Labor Statistics, "The Employment Situation – September 2012".

15. Brookings analysis of US Census Bureau's Public Use Microdata Sample files from the American Community Survey.

16. US Department of Agriculture (2009), "Summary Report: 2007 National Resources Inventory", Natural Resources Conservation Service and Iowa State University.

17. Elizabeth Roberto (2008), "Commuting to Opportunity: The Working Poor and Commuting in the United States", Brookings.

18. National Highway Traffic Safety Administration (2012), "2011 Motor Vehicle Crashes: Overview", US Department of Transportation.

19. Tim Lomax, David Schrank and Bill Eisele (2013), "Urban Mobility Report", Texas A&M University, Texas Transportation Institute.

20. This assessment comes from the 2007 Failed States Index prepared by The Fund for Peace and *Foreign Policy* magazine. The index employs a rating of 12 social, economic and political/military indicators, as well as other assessments of institutional capabilities.

21. While a recent analysis in New Jersey showed increased toll revenues albeit with less traffic, that gain is attributed to toll increases to which there is a limit of how high they can get. Associated Press, "Traffic Down but Revenues Up on Turnpike, Parkway", NorthJersey.com, January 29, 2013.

22. Washington Metropolitan Area Council of Governments, "Accuracy of Growth Forecasts Made 20 Years Ago Varied From Jurisdiction to Jurisdiction", *TPB Weekly Report*, January 8, 2013.

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Chapter 4

New Driving Forces in Mobility:
What moves the Dutch in 2012 and beyond?

Jan van der Waard[1]
Peter Jorritsma[5]
Ben Immers[6]

Abstract

A mobility analysis, carried out in early 2011 by the Netherlands Institute for Transport Policy Analysis, showed that, following the remarkable growth in the 1980s and 1990s, the overall national mobility of the population in the Netherlands has not increased since 2005. This particularly appears to apply to car use. Except for the credit crisis around 2008-09, the reasons for this development remained unclear at the time. Based on further analyses of the developments in mobility over the last ten years and some findings from other countries, the following four hypotheses related to the apparent stabilisation of car use were formulated and investigated in further research:

- The mobility system has started to show signs of "saturation"; for instance, in car ownership levels, a reduced need for mobility to perform activities, less need to increase activity opportunities due to improvements in the mobility system, structural frictions in housing and labour markets, etc.;
- The broad implementation of the (mobile) Internet in society (e-working, e-shopping, e-commerce, use of social networks) is leading to a reduction in physical (car) mobility;
- The mobility of young adults is declining as a result of changes in socio-economic, spatial and cultural factors;
- National mobility is being taken over by international mobility.

In the first part of our contribution, a detailed description of the developments in mobility between 2000 and 2010 is presented, with emphasis on specific trends for various user categories (by travel mode, by age group, by gender). This part can be seen as a description of recent developments in mobility growth.

In the second part we present the findings of our recent research related to the four hypotheses. As some of these findings differ somewhat from research results in other western European countries, we will also focus on these differences and their possible explanations. We conclude this part of the contribution by formulating some possible implications from our findings for transport policymaking.

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[6] TRAIL Research School, Delft, The Netherlands.

1. Introduction

In early 2011, the Netherlands Institute for Transport Policy Analysis performed a mobility analysis, focussing on recent trends. This analysis showed that, following the remarkable growth in the 1980s and 1990s, the total national mobility of people in the Netherlands has not increased since 2005. This particularly appears to apply to car use. Except for the economic crisis around 2008-2009, the reasons for this development remained unclear at the time. Based on further analyses of the developments in mobility over the last ten years and some findings from other countries, the following four hypotheses related to the apparent stabilisation of car use were formulated and investigated in further research:

- The mobility system starts to show signs of "saturation", for instance saturation of car ownership levels, reduced need for physical mobility to perform activities, structural frictions in housing and labour markets, etc.;
- The mobility of young adults is decreasing as a result of changes in socio- economic, spatial, and cultural factors;
- The broad implementation of (mobile) Internet in society (e-working, e-shopping, e-commerce, use of social networks) is leading to a reduction in physical (car) mobility;
- National mobility is being "substituted" by international mobility.

In the first part of this contribution, a more detailed description of mobility developments between 2000 and 2011 is presented, with emphasis on specific trends for various user categories (by travel mode, by travel purpose, by age group, by gender).

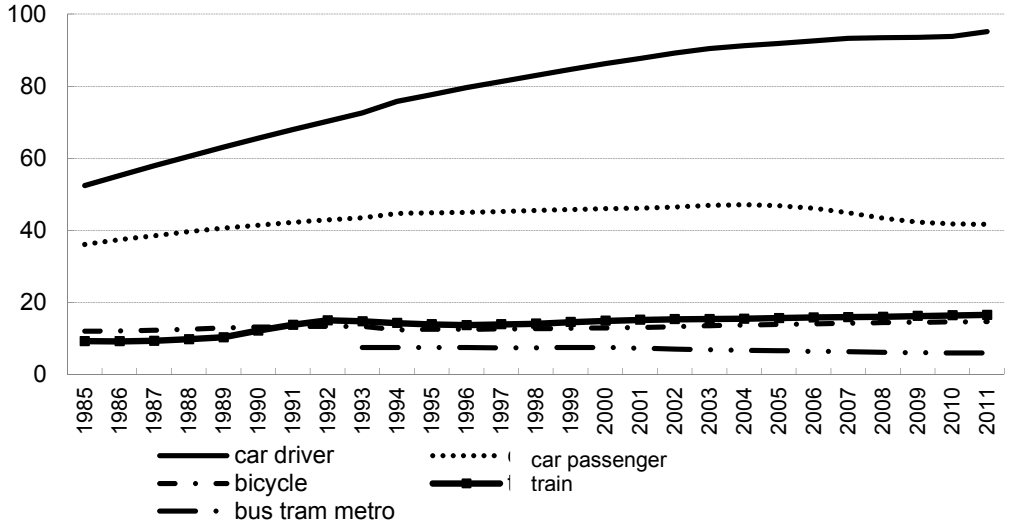
The second part presents the findings of recent research related to the four hypotheses mentioned above. As some of these findings differ somewhat from research results in other Western European countries, attention is given to these differences and their possible explanation.

The last part of the contribution focuses on the findings' possible implications for transport policymaking.

2. Developments in Dutch mobility over recent years

The total number of kilometres travelled in the Netherlands by Dutch inhabitants of 12 years and older has increased over the last 25 years by about 40%. This strong increase took place primarily in the 1980s and 1990s. Between 2000 and 2011 the number of kilometres travelled showed a rather more modest growth of around 4%. Since 2005 there even appears to be a stabilisation in total mobility. Over these same last 25 years there has been very little change in the number of trips each person makes and the time people spend travelling. The Dutch regularly make about three trips a day on average, which total around one hour. Between 2000 and 2011, the population of the Netherlands increased by 4.7%. Figure 1 shows the development in passenger-kilometres in the various modes from 1985. For the bus, tramway and metro, reliable data are available only from 1993 onward.

Figure 1. **Traveller kilometres by mode 1985-2011 in billion kilometres**



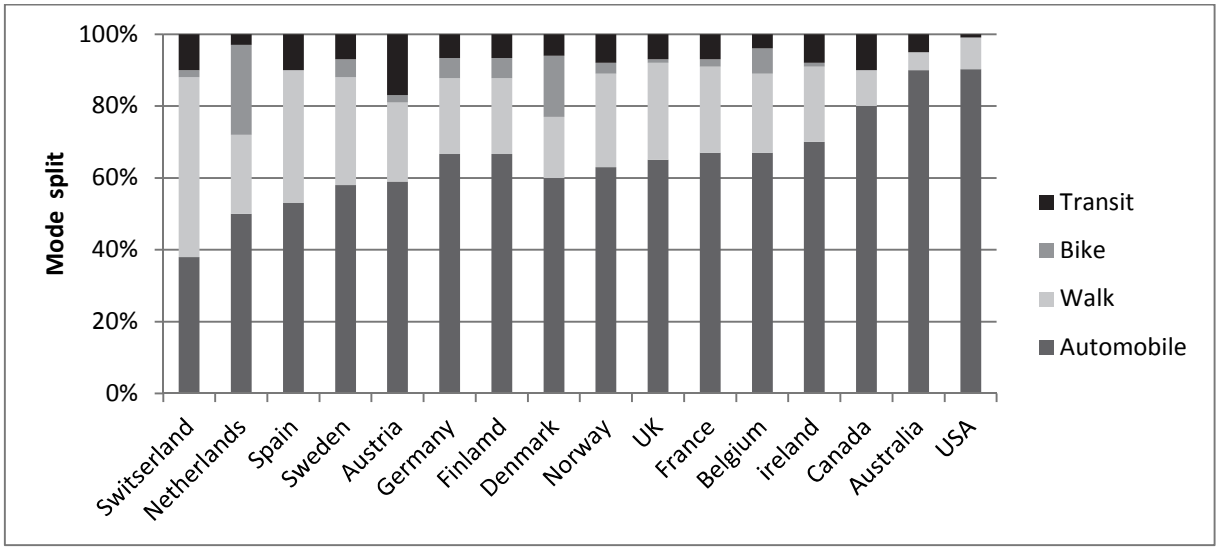
Source: OVG/MON/OViN.

From Figure 1, the important role of the car in the total mobility system becomes apparent. Around half of all trips in the Netherlands are made by car, 25% by bicycle, 20% walking and 5% by public transport. Since 2000, this distribution has hardly changed. As was already visible in Figure 1, the distribution in terms of passenger-kilometres is quite different. Around 75% of all kilometres are travelled by car, 13% by public transport and 8% by bicycle. Cycling concerns mainly short distances, while the train primarily serves the long-distance market.

Most of the trips people make are over relatively short distances. Forty per cent of all Dutch trips are less than 2.5 kilometres and 70% are less than 7.5 kilometres. Around a quarter of all trips are longer than 10 kilometres, but this category represents around 80% of all kilometres. Over distances of up to 7.5 kilometres, cars and bicycles compete. In this market segment, both have a share of about

35%. Public transport plays a minor role for short-distance travel, but has a strong market share on longer distances. Given the position of the bicycle in the Dutch mobility system, environmentally friendly modes have a high share in the Netherlands when compared to other countries (see Figure 2).

Figure 2. **Modal split (based on trips) personal travel in several countries**

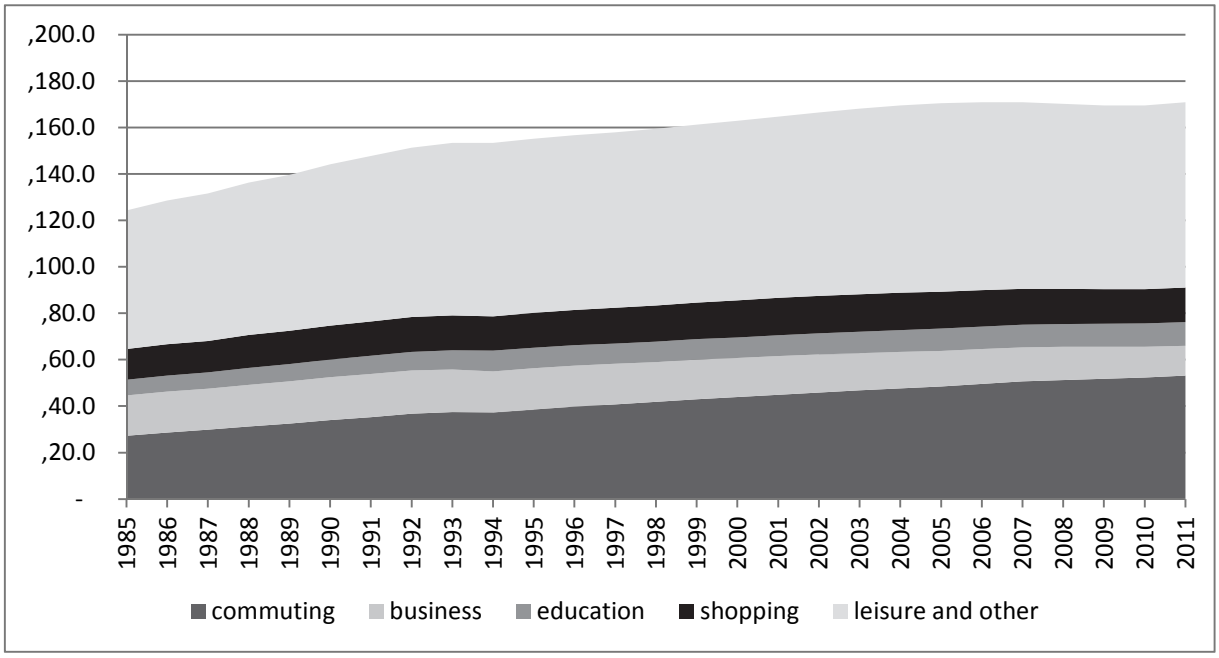


Source: Bassett, *et al*., 2008.

People travel for various reasons. Daily work, doing your shopping, visiting friends and relations or a leisure centre, are all activities that require mobility. Looking at the distribution by trip purpose of the total number of kilometres travelled in the Netherlands, two things are remarkable. The first is that roughly half of all kilometres are associated with leisure travel. The second is that growth over the last decade has mainly been in work-related mobility. From 2000, this has increased by around 18%. In the past 20 years, work-related mobility has even doubled in size (see Figure 3).

The increase in passenger-kilometres associated with the daily commute is mainly a result of an increase in the number of Dutch people working and an increase in the average commuting distance. In the past 25 years, this average distance (one-way) increased from nearly 12 kilometres to around 18 kilometres. Note that the average commuting *distance* varies considerably among regions, with shorter distances in the densely populated Randstad area. In contrast, travel *times* are somewhat longer than average in the Randstad area, because of more congestion in this area. The opposite can be seen in the more rural areas in the eastern part of the country, where relatively short travel times are associated with, on average, longer commuting distances.

Figure 3. **Person-kilometres by trip purpose, 1985-2011 (persons 12 years and older)**



Source: KiM, based on OVG/MON/OViN.

3. A closer look at car mobility in recent years

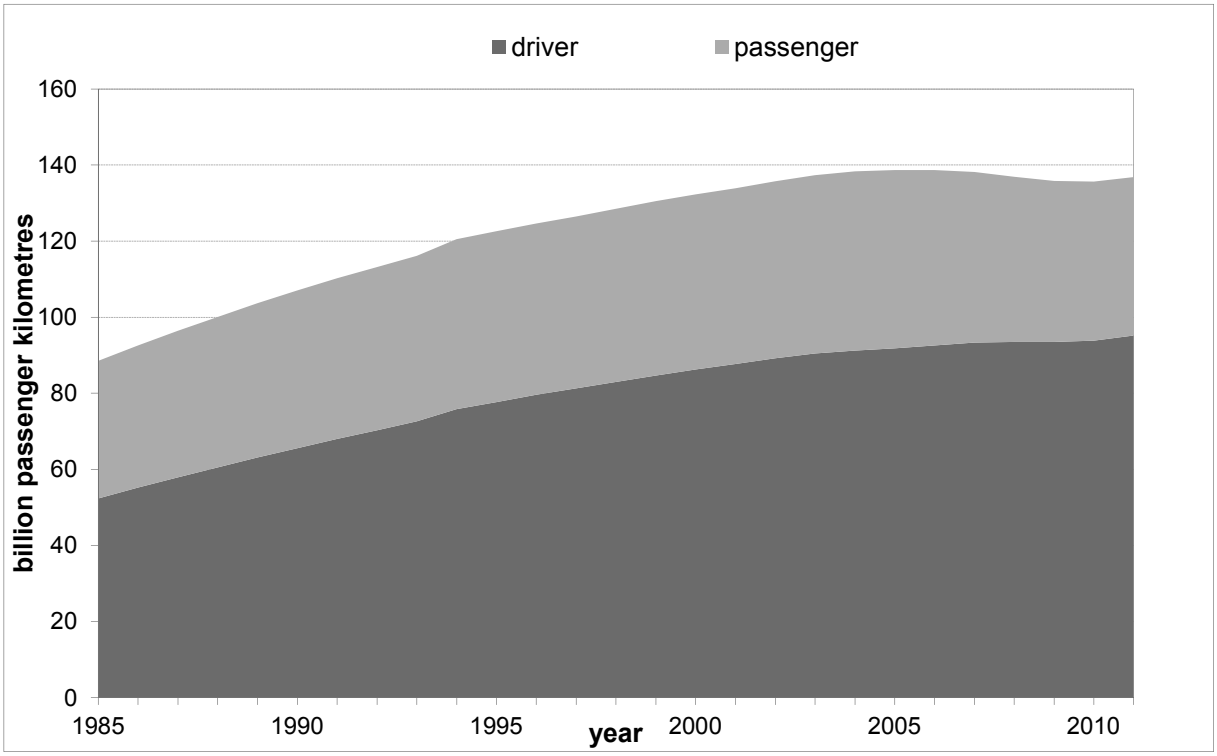
3.1 Stabilisation

Figure 1 showed that growth in mobility is predominantly a result of increased car use (both drivers and passengers). In more recent years (2000-2011), the number of kilometres travelled by car increased by only 3.5% (see Figure 4).

Figure 4 illustrates that car use by drivers and by passengers show rather different developments. The number of kilometres that the Dutch ride as car passengers (around one-third of current car mobility) decreased by 9%, while the number of kilometres travelled by car drivers increased by 10% over the same period. Clearly, car occupancy has fallen significantly during the last decade.

Around 2005, car use (passengers + drivers) in the Netherlands became stabilised. This is the net effect of the actual decrease in kilometres made by car passengers and a slight increase in the number of kilometres travelled by car drivers (and therefore by cars). This growth in car driver kilometres levelled off during the economic crises and increased again slightly in 2011.

Figure 4. **Car use by persons of 12 years and older, 2000-2011, in billion km**



Source: KiM, based on OVG/MON/OViN.

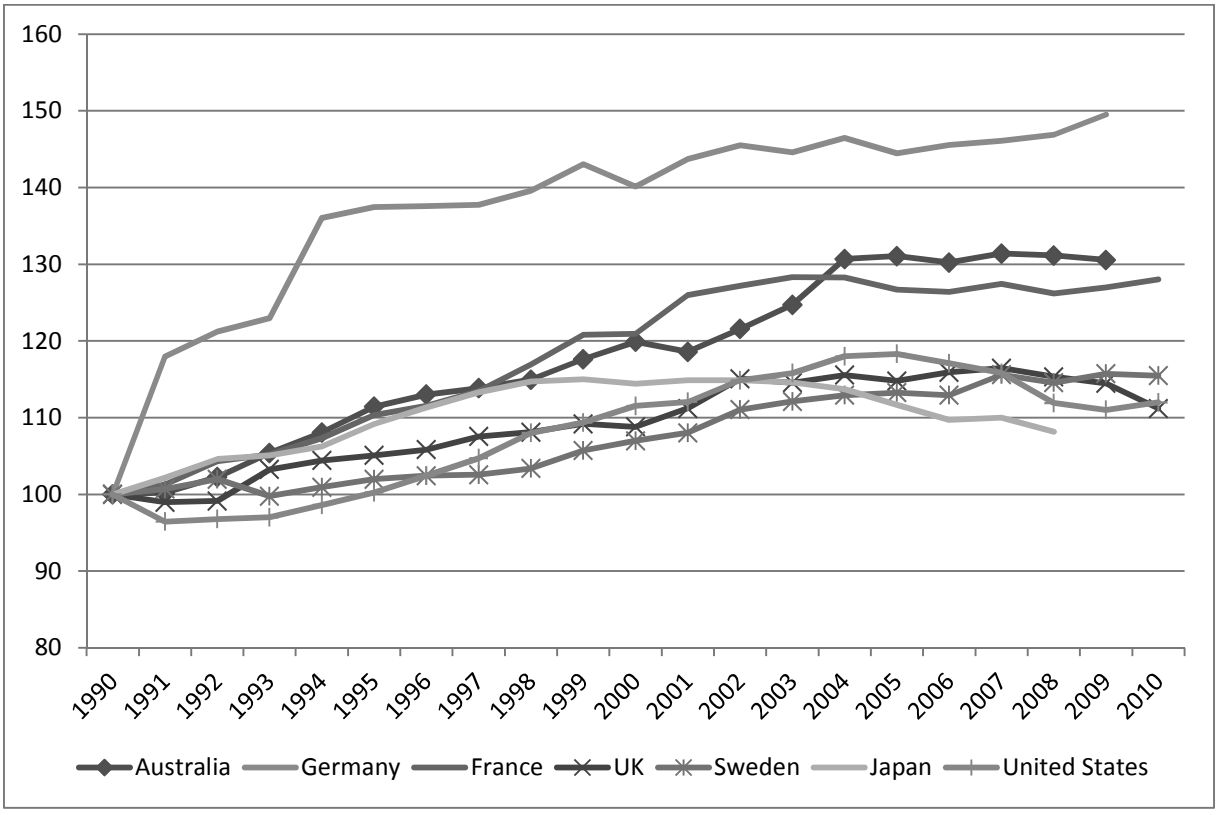
A comparable pattern can be seen on the motorway network, where traffic levelled off from 2007, slightly decreased in 2009 and 2010 and increased again in 2011 (by around 3%). The differences in developments between the total mobility of car drivers and the developments in traffic on the motorway network are caused by developments in goods transport, in the use of vans, the use of the network by foreign vehicles, and a possible shift from the underlying network as a result of the strong decrease in congestion in 2011 on the motorways due to infrastructural improvements (new roads, extra lanes). Developments in 2011 suggest that the trend towards stabilisation will not necessarily continue in future years.

3.2 Developments in other countries

The stabilisation of car use in recent years is also occurring in other developed countries. Close to the Netherlands, in Flanders (Belgium) a decrease in both car passenger and car driver kilometres was noted in 2008 (Janssens *et al*., 2011). In both Germany and the United Kingdom, the number of car -kilometres per inhabitant has not increased since the mid-1990s. In the United States, a formerly steady growth in car use also appears to be levelling off since 2005, while economic and demographic growth continued (USDOT, 2010). Figure 5 shows an overview of the growth pattern in several OECD countries. Note that in Japan stabilisation already began in the 1990s, followed by an actual decrease from 2003. In most other countries, the tipping point from constant growth to stabilisation is visible around 2003 and 2004. An overview of the developments in car use in 25 countries is presented

in a recent report by the Australian Bureau of Infrastructure, Transport and Regional Economics (BITRE, 2012).

Figure 5. **Traveller kilometres for cars and light trucks, 1990–2009**
Index: 1990=100



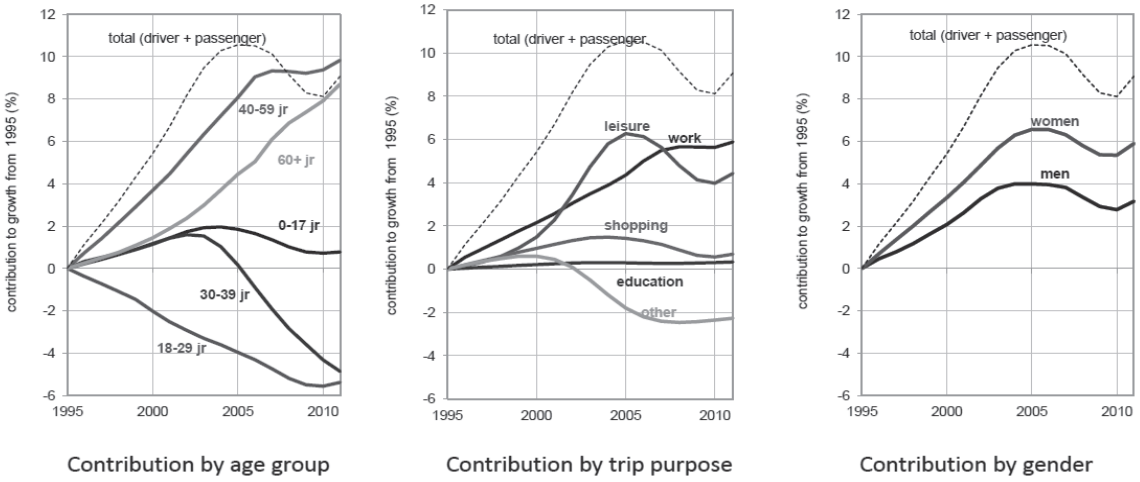
Source: International Transport Forum (2012).

3.3 Differences in the broad picture between various mobility segments

Figure 6 shows in more detail how different groups have contributed to the development of car mobility (driver and passenger) from 1995. Note that the contributions in these graphs include the effects of changing sizes of the various segments considered.

The graph on the left shows that the contribution to the growth in car mobility comes from the over-40s group. The young adults group (18-29) has been responsible for a decrease in car mobility. The trip purpose graph (middle) clearly shows that work-related car mobility made a strong contribution (around 4%) to growth until 2007, after which there was a stabilisation. In leisure, a strong fall in the contribution to car mobility can be seen from 2005, after a period of strong contribution to growth. The graph on the left shows that women have made a stronger contribution to the growth in car mobility than men. For both groups, a decrease in the contribution to growth after 2007 is noticeable.

Figure 6. **Contributions by different segments to the development of car mobility between 1995 and 2011**



Source: KiM, based on OVG/MON/OVIN.

Table 1 shows an overview of the volume developments in the various age groups during the period 1995-2011 and the corresponding changes in contribution to car mobility (kms as driver + kms as passenger).

Table 1. **Developments in population segment and corresponding car mobility, 1995-2011** (kilometres travelled as driver or passenger)

Age group	Population growth 1995-2011	Share in population 1995	Share in population 2011	Change in car mobility in category	Contribution to change in total car mobility	Share of car in mobility 1995	Share of car in mobility 2011
0-17	2.8%	22%	21%	7.3%	0.8%	11%	11%
18-29	-12.1%	18%	15%	-26.5%	-5.4%	20%	14%
30-39	-17.4%	16%	13%	-20.2%	-4.9%	24%	18%
40-59	22.5%	26%	29%	28.4%	9.8%	35%	41%
60+	36.4%	18%	22%	84.6%	8.7%	10%	17%
Total	7.8%	100%	100%	9.1%	9.1%	100%	100%

Source: KiM, based on CBS Statline and OVG/MON/OViN.

For young adults (18-29), it is remarkable that their car mobility dropped by 27%, while their group size decreased by only 12%. In this age group, there has clearly been a marked decline in car mobility on an individual basis.

In the age group 60+ we see a reverse trend, with an increase in car mobility (+85%!) which is much larger than the growth of this population segment (+37%). This means that, on an individual basis, the car mobility of those over 60 has increased. This is a logically explainable trend, as more and more individuals are joining this age group and car ownership and use are a common experience for them. In earlier years, licence holding and car ownership were lower among elderly women. Furthermore, during this period, income levels have increased for this group. The increased car mobility in this group is mainly related to social and leisure activities; work and education-related trips hardly play any role. Analysing developments in more detail, the increase in work-related car mobility after 2005 is noticeable, especially among men; this results from prolonged working participation.

3.4 A specific look at car drivers

To further analyse developments in the mobility of both car drivers and passengers, we examine three contributing factors:

1. "Changes in demographics": Changes in the composition of the population will result in changes in the number of persons participating in various activities;

2. "Changes in frequency": People may change the frequency of their trips as car driver (or car passenger) for their various activities. This effect can result from three different changes in activity patterns:
   a. Changes in the percentage of the population that participates in the activity;
   b. People change their activities on an individual level;
   c. People quite often choose car driver (or car passenger) as a mode to travel for a specific activity;

3. "Changes in trip length": The average trip length for a specific type of trip may change.

In the analyses, a distinction was made between various trip purposes.

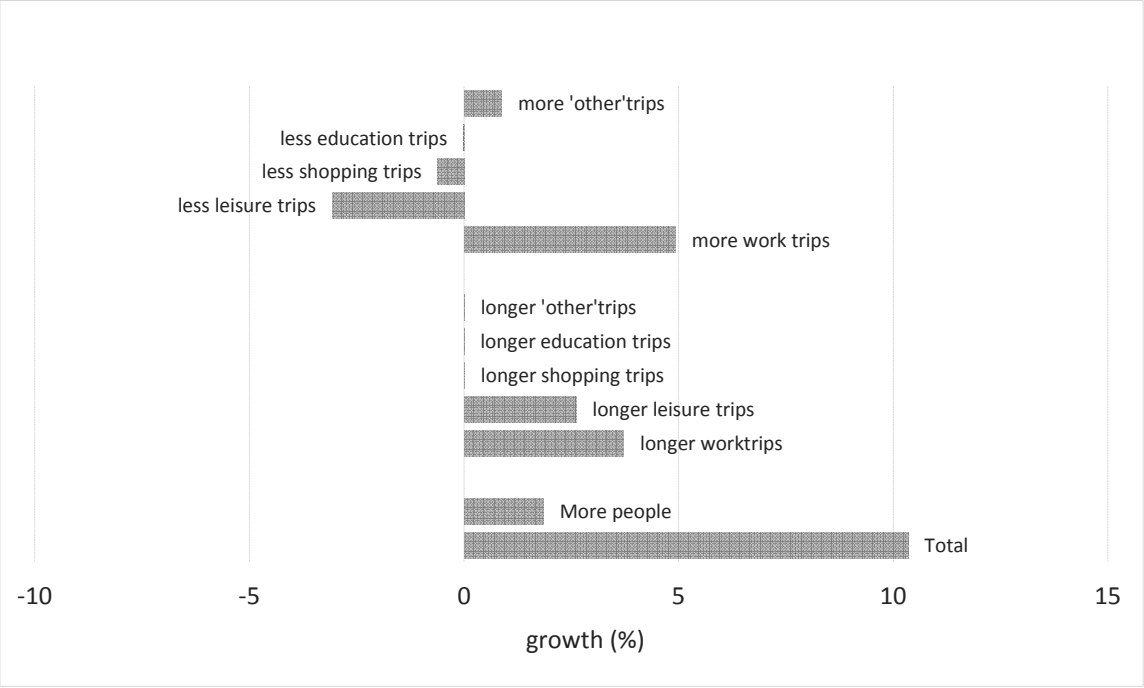
As mentioned before, the total kilometres travelled by car drivers increased by 10% between 2000 and 2011. The result of the breakdown among the three categories mentioned above is presented in Figure 7.

The 10% increase appears to be mainly caused by (1) an increase in the population, and (2) driving more often and further to and from work. Furthermore, it is clear that, due to increased car ownership, a significant part of the extra kilometres as car driver originates from kilometres formerly travelled as car passenger. A second important influence in this component must have come from increased labour participation by women; the increase in this component is one and a half times higher for women than for men.

For non-work trips, the number of trips per person has dropped. But, as we travel further for these trip purposes, the number of kilometres per person did not change significantly between 2000 and 2011.

It is estimated that, if fuel prices had stayed constant in real terms (instead of the 16% rise), the total number of kilometres travelled as a car driver would have been 2 to 3% higher.

Figure 7. **Size of different components in the development of car use (drivers) 2000-2011**



Source: KiM based on OVG/MON/OViN.

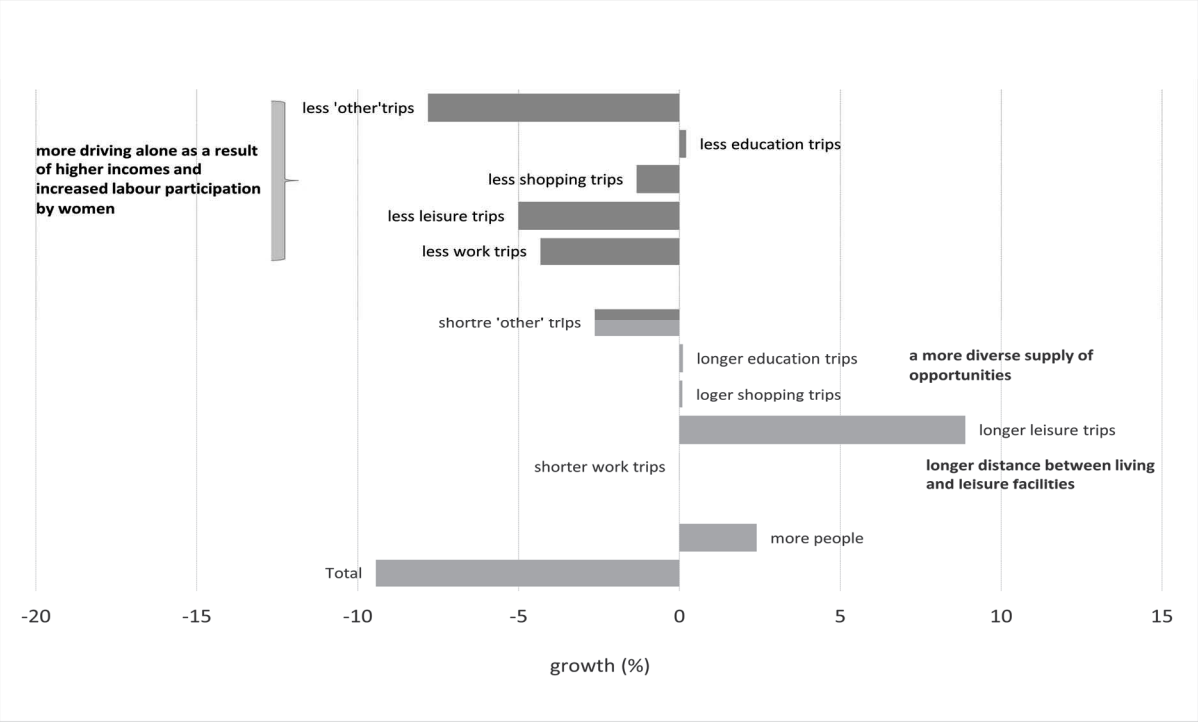
Although the Dutch had around three hours a week less leisure time available in 2005 compared to thirty years ago, this had no consequences for the leisure time spent outside their houses (Verbeek and De Haan, 2011). Therefore, an increasing part of their leisure time involved mobility. Over the last 25 years, the number of trips and the number of kilometres travelled has increased as a result of increased incomes, a growth in car ownership and a decrease in running costs. Apart from that, the available supply in leisure facilities increased by an estimated 800% since the mid-eighties (Metz, 2002). Nowadays the volume of leisure travel has stabilised and even slightly decreased since the economic crisis. Between 2003 and 2007, trip distances increased, but trip frequencies decreased. The increased trip distances could be correlated with scale developments in the leisure industry in the form of a larger and more varied supply of leisure attractions (PBL, 2010).

The decrease in leisure travel in more recent years can possibly be correlated to the rise of the Internet and the use of social media, offering more possibilities for leisure activities at home. Available research data on how leisure time is spent do not yet offer enough insight into such developments. Another possible explanation could be an increase in leisure travel abroad, possibly in other modes (airplane). This issue will be addressed later on. The developments are not equal for all age groups. Although not strong enough to change the total image of the decrease, we do see an increase in the number of leisure trips by older persons.

3.5 A specific look at car passengers

As mentioned before, the total number of kilometres travelled by car passengers decreased by over 9% between 2000 and 2011. The result of the decomposition along the three components mentioned earlier is presented in Figure 8.

Figure 8. **Size of different components in development car use (passengers) 2000-2011**



Car use as a passenger has decreased for nearly all trip purposes. This development can be seen in nearly all age groups, apart from the elderly (60+). This trend fits with a more general societal trend of individualisation and an increased appreciation of autonomy and independence. Higher income levels, increased driver licence holding and increased car ownership have made this possible. Furthermore, the increased labour participation of women has played a role. The major part of the half a million jobs added in the Netherlands between 2000 and 2011 were taken by women (*source*: CBS). However, for the work-related trip purpose, the decrease in car mobility generated by men is greater. For the non work-related trip purpose, women contribute most to the reductions. That the car passenger mode does not drop in importance among the elderly is predictable. In part, this concerns generations from before the "individualisation" trend, but apart from that it is imaginable that couples in this life stage choose to participate in activities together, while others are no longer able to travel by car on their own.

The number of car passenger-kilometres would have dropped even further if two contrary developments had not occurred: the first is an increase in length of passenger trips - this is primarily visible in leisure travel; the second is that the total number of inhabitants grew in the period considered.

4. Possible causes of the reduced growth in car mobility

4.1 Which causes to look at?

The analysis presented above, together with comparable research in other countries, support one common image, which is that the economic crisis and increasing fuel prices do not entirely explain the reduced growth in car mobility. In this section, the possible causes of this trend are further investigated. Based on an inventory of the kinds of driver considered in research in other countries and based on findings from the analyses presented above, the following four possible causes for the reduced growth in car mobility will be explored in more detail:

1. *Saturation in direct influencing factors*. Such factors can directly relate to the transport system (for instance, a saturation in car ownership levels) or lie outside the system (e.g. limitations in the amount of time spent on certain activities);
2. *Changing mobility of young adults*. From recent international research (Kuhnimhof *et al.,* 2011, 2012) and from our own analysis, it becomes apparent that young adults are much less mobile than they were 10 to 15 years ago. What could explain this reduced demand for mobility?
3. *Rise of the Internet society.* There are expectations of reduced mobility as a result of changes from physical to virtual activities;
4. *Increased international mobility of Dutch inhabitants.* International mobility is rather poorly incorporated in our travel statistics. The Dutch appear to be travelling more often and to further destinations abroad, especially for their holidays. It is possible that such trips are starting to substantially replace shorter trips in the Netherlands.

In the following paragraphs each of these four possible causes for the reduced growth in car mobility is considered in more detail.

4.2 Signs of saturation for some drivers

Car ownership and drivers' licence holding

The availability of a car is an important prerequisite for car use, although this does not automatically mean that one needs to own a car to be able to use it. Currently, around 8% of the automobiles in the Dutch car fleet are leased (Jeekel, 2011). In addition, there are several car-sharing initiatives in the Netherlands, currently comprising over 2 600 vehicles.

Car ownership in the Netherlands increased from 362 cars per 1 000 inhabitants in 1995 to 460 cars per 1 000 inhabitants in 2011. In the Randstad area, car ownership levels are around 420 cars per 1 000 inhabitants, while in less densely populated areas car ownership levels are well over 500 cars per 1 000 inhabitants. Between 1990 and 2011, car ownership in the Netherlands grew quite steadily, by 1 to 2% per year. There are no apparent signs of saturation. However, car ownership levels in other OECD countries seem to have already reached a saturation level, although this level differs among the countries. In the United Kingdom a stable level of around 500 cars per 1 000 inhabitants

appears to have been reached, while the stability figure is around 600 in France and Japan, 700 in Australia and even 800 in the United States.

Table 2 shows that, over the last 20 years, car ownership of households in the Netherlands changed significantly. An increasing proportion of the population has become a member of a household with two or more cars. Paradoxically, although there has been increased car ownership, there has been a slight increase in the share of people in households with no car. The changing household size, with an increasing number of one-person households, plays a role here. Among one-person households, 57% have a car available, while this percentage is 96 for four-person households (Jeekel, 2011).

Table 2. **Distribution of persons in households with different car availabilities**

	1991	**2001**	**2011**
Persons in households without a car	13%	14%	15%
Persons in households with one car	67%	58%	49%
Persons in households with two cars	18%	25%	31%
Persons in households with three cars or more	2%	3%	5%

Source: OVG/MON.

Between 1995 and 2009, the percentage of the Dutch population (over 18) holding a driver's licence has increased from 80 to 84%. The increase was mainly among young people in the 18-24 year age group and among the group of over 50s. There was a small decrease among young adults between 25 and 29 years old.

Sivak and Schoette (2011) have analysed driver-licence holding in 15 countries between 1983 and 2008 (see Table 3). In each country, an increase among the elderly can be observed. In the Netherlands, as with countries like Spain and Switzerland, increases are visible in the very young and the elderly age groups. In this latter group, only Switzerland, like the Netherlands, shows car mobility to be stabilising. In countries such as the USA and Germany, a reduction in young drivers can be seen and in several other countries car mobility appears to be stabilising.

Table 3. **Changes in driver-licence holding in various countries**

Decrease among young people and increase among the elderly	Increase among both young and elderly people
USA	Spain
Sweden	Finland
Norway	Poland
UK	Israel
Canada	Latvia
Japan	*Switzerland*
Germany	***The Netherlands***
In italics: stabilising car use	

Source: Sivak and Schoette, 2011.

Income levels

Income levels appear to have a direct relationship with car ownership and car use. With growing income levels, car mobility increases. Several sources (Goodwin, 2012; Millard-Ball and Schipper, 2011) indicate that, in recent years, car use by households appears to level off above a certain level of household income. In the US, this trend is clearly visible (ITF, 2012). An analysis performed by the Central Bureau of Statistics (CBS, 2008), shows the direct relationship between household income and car use; the analysis also shows a drop in car use in each income category after 2005, in line with the development in total car mobility. However, what cannot yet be seen in the Netherlands is a levelling off of car use above a certain level of household income.

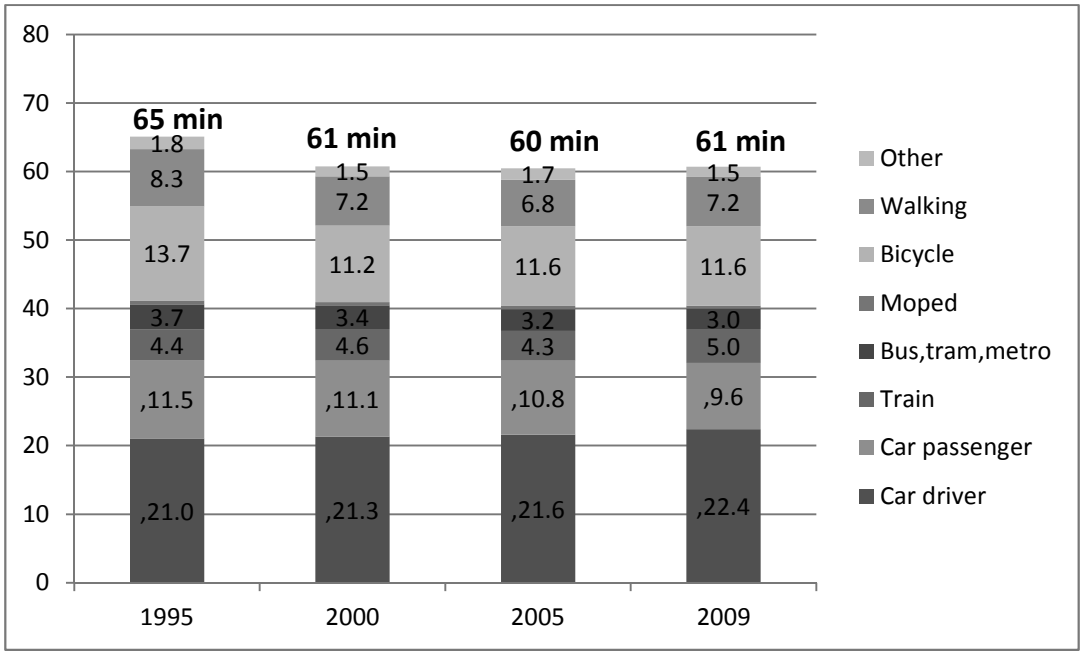
Labour participation by women

Compared to other western European countries, the Netherlands used to have a relatively low participation of women in the labour force. Over the last 20 years, however, this situation has changed rapidly and has been identified as a major cause of increased car mobility. As mentioned before, women more often use the car for work-related activities. Each extra working woman not only results in two extra trips on each working day, but also in travel by car for other trip purposes. The combination of work, running a household and taking care of children calls for flexible mobility, for which the car is an ideal mode. As a result, the mobility pattern of these women has started to resemble more and more the men's mobility pattern. The so-called "gender gap" seems to be nearly closed. Apart from this, an increased level of education among women has also played a role here (see Olde Kalter, Harms and Jorritsma, 2011). However, from around 2007, the trend described above appears to change. From that moment, the level of labour participation by women stabilises at 60% and for men it even decreases slightly. These developments are most likely related to the economic crisis.

Changes in travel times

The Dutch population spends about one hour each day travelling. Over recent years, little has changed in this pattern (see Figure 9). Also, travel times by car have not significantly changed. In 2009, on average, the Dutch spent slightly more than 32 minutes in a car each day. This has not changed from 1995. As mentioned before, what has increased is the travel time spent in commuting.

Figure 9. **Travel times per person per day by travel mode (in minutes), 1995-2009**



Source: OVG/MON.

Conclusion

Contrary to other OECD countries, where a reduction (in growth) in car use is apparent, there are no real signs of saturation as an explanatory factor for reduced car mobility in the Netherlands. The factors considered in the analysis can hardly have played a significant role in the levelling off of car mobility growth. An exception to this is the level of labour participation by women. In the last two decades, the existing "gender gap" has more or less closed and, from 2007 on, labour participation by women seems to stabilise, which could be correlated with the economic crisis. This phenomenon is likely to have caused part of the decrease in car mobility in more recent years.

4.3 Mobility of young adults

Introduction

The current young adult population, between 18 and 30 years of age, is often called "Generation Einstein" or "Generation Y". They have grown up in the IT era, where computers have no secrets for them, mobile phones or Smartphones are indispensable to them and they appear to be constantly "on line". They are more independent and more individualistic than their peers of 10 to 15 years ago. Collective values seem to be less important to them and small social networks all the more important. These are a number of conclusions from a book by Spaanenberg and Lampert (2011) on the present-day younger generation. Whether this way of life is also reflected in alternative travel behaviour is the question that we will try to answer here.

From other (American) research, it can be learned that two-thirds of young adults (both students and workers) prefer having an Internet connection to having a car of their own (CISCO, 2011). The development towards an e-society could be of influence on the way the young generation perceives cars. An indication that Generation Y prefers to own a smartphone rather than a car can be found in the following quote from Business Week: "*Though the car is still a gateway to independence, Generation Y has more ways to connect with the outside world than young buyers of past generations*" (Business Week 2012).

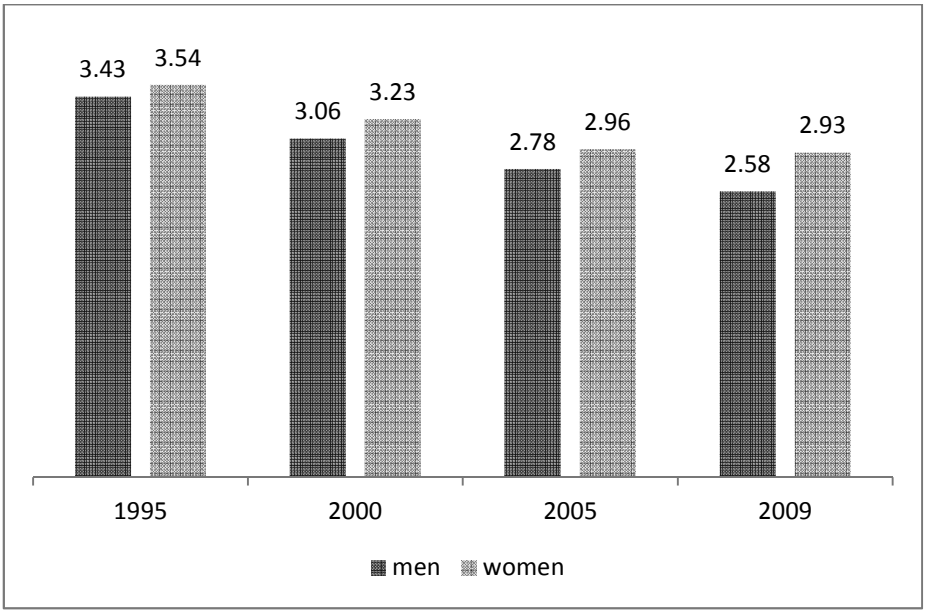
The research on mobility behaviour among young adults in Germany and the United Kingdom (Kuhnimhof *et al.,* 2011, 2012) shows a strong shift towards more use of the bicycle and public transport, indicating a change in "orientation" away from the car. The same type of changes in mobility patterns can be seen in the US. For the Netherlands, a comparable type of research effort was made based on data from the annual mobility surveys of 1995-2003 [Onderzoek Verplaatsingsgedrag CBS (OVG)] and 2004-2009 [Mobiliteitsonderzoek Nederland RWS (MON)]. In addition to this quantitative research and, in co-operation with the Netherlands' Institute for Social Research (SCP), a number of focus group meetings were organised to gain more insight into the underlying factors influencing the mobility patterns of young adults (Veldkamp, 2012).

Decreasing mobility among young adults

As illustrated before, young adults nowadays travel a lot less by car. What was not mentioned before is that, in general, they are less mobile than around 15 years ago. The total number of trips per person per day made by young adults between 1995 and 2009 decreased by 21%, from 3.49 to 2.75 trips per day per person. Young adults also travelled significantly fewer kilometres. In 1995, this was on average 41 km per person per day; in 2009 this was 38 km per person per day ─ a decrease of 7%. They also spend less time travelling. In 1995 this was on average 77 minutes per person per day, which was reduced to 68 minutes per person per day in 2009.

These are overall averages. But, there are some differences between men and women. Young women make more trips than young men, but the length of their trips is shorter. Between 1995 and 2009, the decrease in the number of trips is smaller among women than among men; but the number of kilometres travelled by women increased by 6% (see Figure 10).

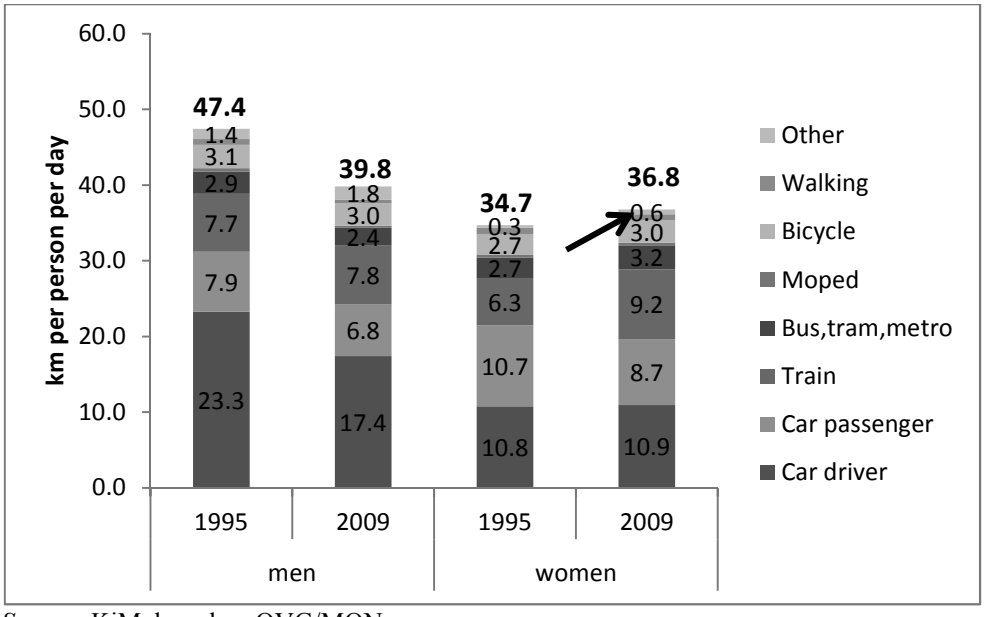
Figure 10. **Number of trips and kilometres travelled per person per day, by gender, for young adults (18-30 years of age)**



Sources: OVG, MON (1995-2009).

Taking a closer look at the various modes (see Figure 11), a clear reduction in all modes can be seen, except for the train. In 2009, young adults more frequently used the train than in 1995 (31% more trips per person per day). Especially among women, public transport use has gone up considerably.

Figure 11**. Number of kilometres travelled by young adults per person per day, by travel mode, 1995 and 2009**



Source: KiM, based on OVG/MON.

In terms of the total number of kilometres travelled per person per day, the men show a 16% reduction (see Figure 11). Entirely in accordance with the number of trips, the reduction applies to all modes. For young women, the picture is a bit different. Although the number of trips by bicycle has decreased, the distance travelled has increased. The same (although in a more moderate way) goes for driving a car. In particular, train usage is growing, not only in terms of trips but also in terms of kilometres travelled per person per day.

Young adults who own a car generally make little use of public transport and the bicycle. However, over the years the use of these modes has increased somewhat. Consequently, car use has decreased significantly. The young adults who do not own a car make much more use of public transport and the bicycle. Their mobility pattern remains more or less constant over time. But, also in this group, a somewhat declining orientation towards the car (as a passenger) seems to have occurred.

More students, fewer young adults working

The composition of the "young adults" group has been changing recently. Although the volume of the age group from 15 to 17 year olds increased by 5% in the period 2001-2011, the number of young adults working decreased by 20% in the same period (Source: CBS). An increasing number of young adults are engaged in education instead of work. In particular, their participation in higher education has increased rapidly. For the age group 18 to 25 years of age, participation in higher education has increased by 40%! These changes in societal positioning have their impact on mobility, since a working young adult travels many more kilometres than a learning young adult (see Table 4). Note that this difference in kilometres per trip purpose has hardly changed over the years.

Table 4. **Annual number of kilometres travelled by car for working and studying -- young adults**

	Men	**Women**	
1995	7 300	3 800	Working
	1 100	600	Studying
2011	6 500	3 700	Working
	1 200	800	Studying

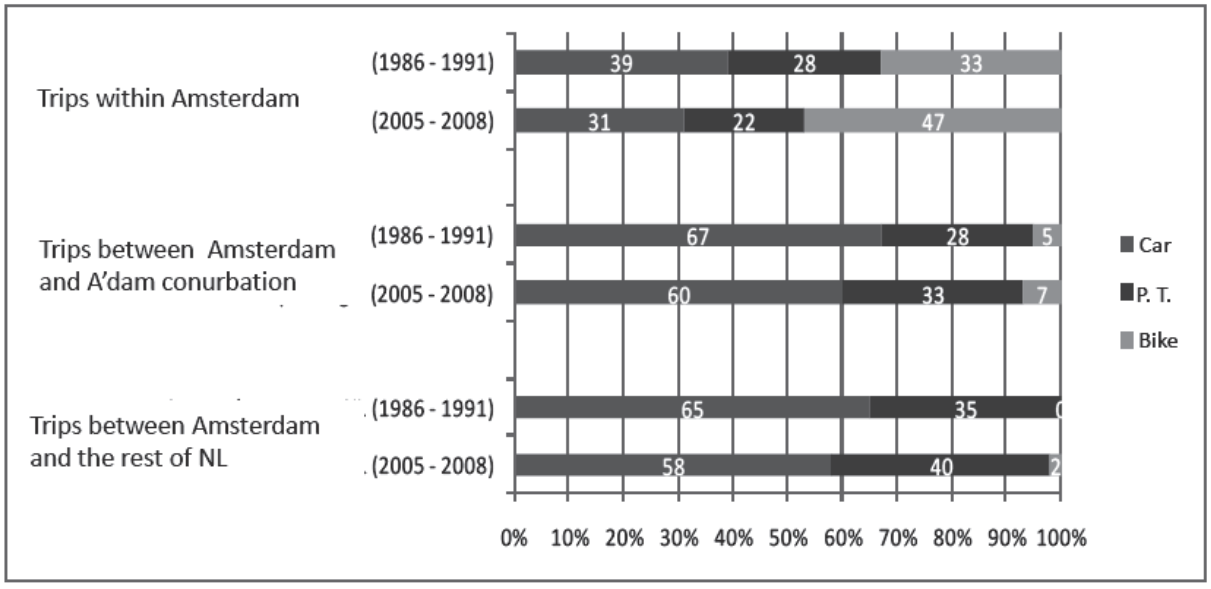
Source: KiM, based on OVG/MON/OViN.

Re-urbanisation

Not only have changes in societal positioning taken place, but (probably partly correlated with this development) young adults more often tend to live in high-density urban areas. Between 1995 and 2009, the share of young adults living in high-density urban areas has increased and their share in moderate-density urban areas and in rural areas has declined. Note that a comparable re-urbanisation trend took place for all other age groups. In high-density urban areas, young adults make more trips per person per day than those living in other areas. They also tend to make longer trips. It needs to be pointed out here that inhabitants of high-density urban areas are much more inclined to use public transport and the bicycle. This can clearly be seen from the situation in a city like Amsterdam, where

one can also notice an increase in the "market share" of the bicycle for shorter distances and public transport for longer distances (see Figure 12).

Figure 12**. Mobility development in Amsterdam**



Source: Amsterdam DIVV (2010), MON/OVG.

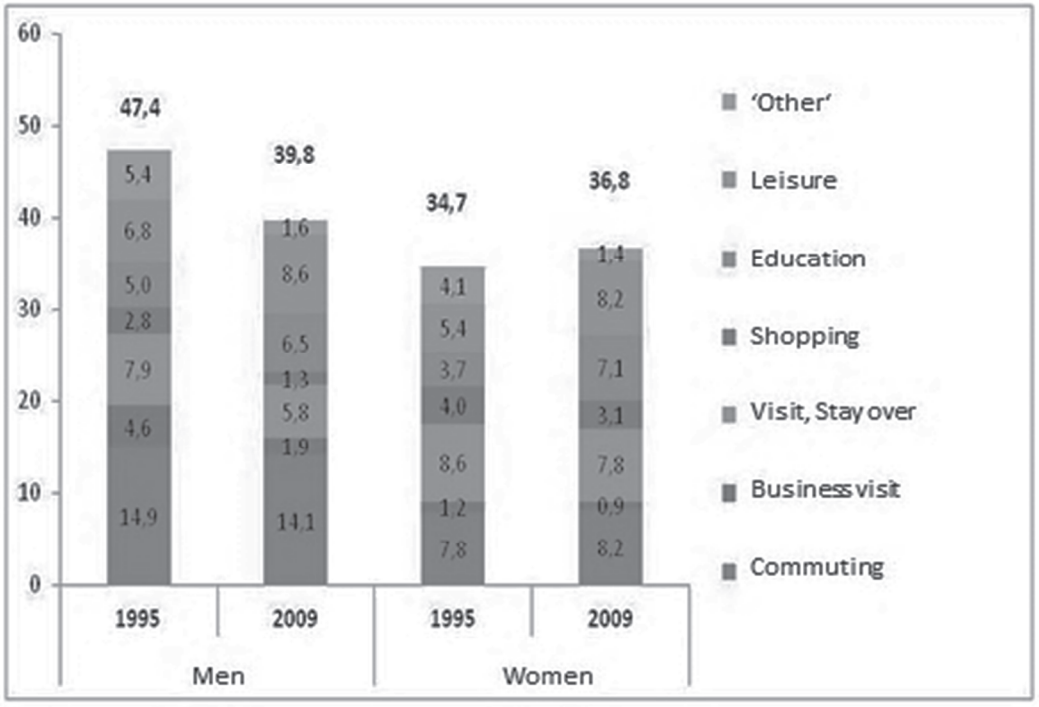
More mobility related to leisure and education; less related to work, social contacts and shopping

In 2009, young adults made more trips for leisure and education purposes than young adults in 1995 (9% and 13%, respectively). In 2009, the trips for these purposes involved longer distances than comparable trips in 1995. The longer trips for educational purposes are due to the concentration of educational facilities. Young adults nowadays make fewer trips for work, shopping and social contacts. The last development could point to an increased orientation of young adults towards activities via the Internet (e.g. to maintain their social contacts).

Although in absolute terms young women travel more kilometres for the trip purposes of "visiting friends and relatives" and "shopping" than their male counterparts, this volume has dropped by 9% and 22%, respectively (see Figure 13). The increased use of the train is probably related to the increased participation in educational activities and the associated availability of a student public travel pass. Nearly one-third of the growth in train use in the period 2000 to 2011 is estimated to originate from the use of the student travel pass.

In line with these developments, travelling by train for leisure and for educational purposes has been increasing. An increasing number of train trips are made over longer distances. There is also an increase in the number of trips by train for work-related trips. However, this does not result in an increase in the number of kilometres travelled per person per day.

Figure 13. **Kilometres travelled per person per day by young adults, by trip purpose, 1995 and 2009**

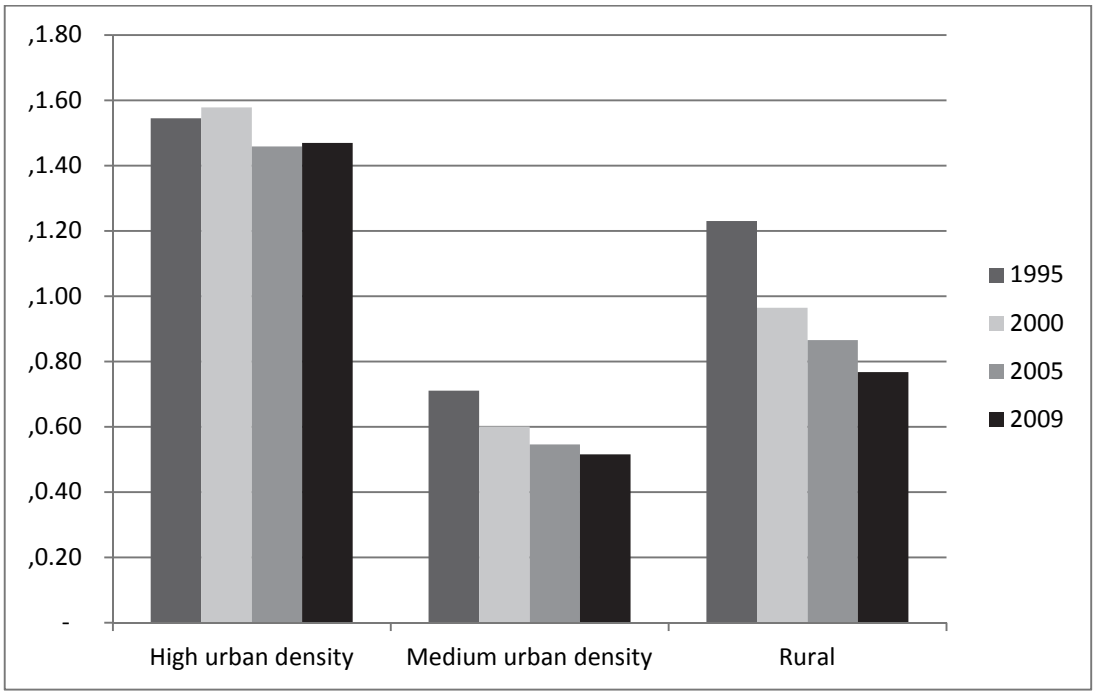


Source: KiM, based on OVG/MON.

Only small reductions in mobility in high-density urban areas; increase in use of public transport and the bicycle

As mentioned earlier, there was an increase between 1995 and 2009 in the number of young adults living in high-density urban areas and a decrease in living in other urban and rural areas. Young adults living in high-density urban areas make more trips and travel more kilometres per person per day than those living in other urban and in rural areas. For people living in urban areas as well as those living in rural areas, the period 2000 to 2009 shows a trend of decreasing numbers of trips and shorter trip distances. In urban areas, this decrease was more modest than in rural areas (see Figure 14).

Figure 14. **Trips per person per day by young adults by dwelling location, 1995-2009**



Source: KiM, based on OVG/KIM.

A more detailed comparison of the situation in 1995 and 2009 shows a strong decrease in the number of trips made by car and on foot by young adults living in both urban and rural areas. In urban areas, one can also see a shift towards the bicycle, local public transport and the train (+9%, +10% and +41%, respectively). This shift also becomes apparent in the number of kilometres travelled per person per day in these modes. This development is in line with the changes in the travel behaviour of young adults in Germany (Kuhnimhof, 2012), although the effect there is much less prominent. This does not necessarily mean that young Dutch adults are lagging behind. It must be remembered that bicycle use was already very high in the Netherlands compared to Germany, and that all Dutch students have had a free public transport mobility pass (for either weekend or weekdays) since 1991. It is quite conceivable that the shift to public transport by young adults that has been seen recently in Germany took place earlier in the Netherlands with the introduction of this card. Please note that young adults living in rural areas also travelled more by train in 2009 than in 1995 (12% more trips and 10% more kilometres per person per day).

Car ownership and driver's licence holding

Having examined the decreased mobility among young adults, the question arises: which factors, apart from the structural changes in societal positions (fewer workers, more students) could have influenced the trends? A closer look at drivers' licence holding and car ownership among young adults shows that there has hardly been any change in these factors between 1995 and 2009: drivers' licence holding stays around the 70% level. Among young males, a slight decrease is noticeable; but, contrary to this, there has been a slight increase among young females. More or less the same trend, but with slightly bigger fluctuations, can be seen regarding car ownership. In 1995, about 32% of young adults owned a car; in 2009 this was 30%. Moreover, car ownership among young adult men decreased from 38 to 33%: most probably this is correlated with their changing societal position (fewer workers, more students). In comparison, there was an increase in car ownership among young adult women.

The reduced car ownership among men possibly explains their greater reduction in car use than that of women.

Labour participation

The number of non-active young adult women (not working, not a student) has decreased significantly in recent years; this trend does not apply to men. The level of labour participation among young adult women increased strongly, as in other age groups. Between 1995 and 2009, labour participation among young adult women rose from 63% to 79%. Over the last few years, the level has stayed fairly constant, as with the rest of the Dutch female population. The strong increase in labour participation significantly contributes to the increase in the number of kilometres travelled per person per day for work-related trips among young adult women.

For men in the same age group, labour participation did not significantly change, remaining around the 90% level. Among younger men there has been a decrease in work-related kilometres travelled per person per day.

When the absolute changes in numbers of workers and students are taken into consideration, there has been a strong decrease in the number of workers. In 2011, there were 176 000 fewer young adults working compared to 2001 (CBS Jeugdstatline, 2012). Combined with the slight drop in car ownership, this accounts for the drop in work-related trips and the associated number of kilometres. At the same time, the number of students among young adults increased by around 136 000 (Source: CBS Jeugdstatline, 2012). A large proportion of these studying young adults live in high-density urban areas, where the major educational institutes are found. Taking this development into account, it is not surprising that the mobility of young adults in high-density urban areas decreased only slightly. Car ownership in these areas is lower than the national average and is even lower among the young. Other modes of transport are more convenient alternatives here, as can be seen from the increase in public transport use and in the use of the bicycle.

Attitudes toward the car

One possible explanation for the decrease in car mobility is a changing attitude of young adults toward the car. Where once a car was seen as the most desirable of goods, today it may seem more important to have digital contacts and experience the freedom of choice of transport modes, depending on the type of activity that one wants to undertake. The focus group discussions mentioned earlier revealed that, in the year 2012, the car still has a high aspiration content for young adults. Having a car equals freedom, independence, availability, comfort and convenience. This proves to be truer for the less-educated than for higher-educated young adults. This seems in contradiction with the observed trends. However, we have no way to compare these attitudes to those about the status of the car in 1995. Such an outcome must therefore be interpreted as a relative judgment, as compared to about 15 years ago. The status of the car among young adults at that time was probably higher than it is now.

Another possible explanation for declining mobility among young adults is the ubiquitous Internet society. Young adults develop increasingly many e-activities through the Internet (social media, Internet shopping) and the mobile phone/smartphone. They are online constantly and the smartphone is one of their basic necessities. This is evident from existing literature and data and is also clear from focus group discussions. E-working has not yet significantly made its appearance among young adults. Certainly, less-educated young adults often have jobs where working at home is not possible (healthcare, retail, driver). The group discussions also revealed that "WhatsApp" possibly partly replaces visiting friends and relatives, resulting in fewer physical social contacts, thus less mobility. This seems in line with the decrease in the number of trips and mileage for the trip purpose

"visiting friends and relations". On the other hand, the participants also indicated that the Internet has an alert function for events, festivals and other activities, which might provoke more trips over longer distances. The alert function of the Smartphone can also lead to increased mobility, because you know where your friends are. This kind of notion may support the finding that young adults increasingly make leisure trips over longer distances.

Conclusion

From the analyses of the data from the Onderzoek Verplaatingsgedrag (OVG, 1995-2003) and the Mobiliteits Onderzoek Nederland (MON, 2004-2009), it can be deduced that young adults aged 18 to 30 years indeed became less (auto) mobile between 1995 and 2009. This refers both to the number of trips and the distance travelled per person per day. This result is in line with the trend found for young German adults. However, unlike the young German adults, the young Dutch shifted much less to bicycle, bus, tram and metro between 1995 and 2009. Exceptions are the young adults in high-density urban areas. Among them, we see a shift towards the bike, (urban) public transport and the train.

The usual explanatory variables, such as having a driver's licence and car ownership, have changed very little over time and therefore offer no adequate explanation for the decrease in car mobility.

Furthermore, the employment rate of women has reached a ceiling and may thus have had an impact on the decrease of mobility among young adults.

The apparent decrease in the number of working young adults, and a clear increase in the number of young adults participating in higher education, undoubtedly have had an effect on car mobility. These developments have gone hand-in-hand with a substantial shift towards living in high-density urban areas.

Although much quoted in publications on reduced car mobility, a significant change in attitude toward the car could not be determined. The existence and possible impact of such a trend remains unclear.

Finally, the impact of the increasing use of social media and smart phones cannot yet be assessed.

4.4 The influence of the Internet society

Introduction

To what extent does the increasing use of IT in society influence the reduction in growth in car mobility? To answer this question, we performed a literature review and desk research, specifically looking at:

- how IT affects daily activities;
- to what possible changes in mobility behaviour IT can lead;
- the extent to which these changes in mobility behaviour also lead to an observable change in mobility (number of trips or kilometres).

Often it is expected that the further digitisation of society will lead to a decrease of physical mobility. However, the separation between physical and virtual activities is not that sharp

(Schwanen *et al*., 2008). IT not only replaces physical activities by virtual activities, it also generates new activities and associated mobility. The (mobile) Internet leads to a change in the organisation of activities. We are still in the middle of this development and new developments are taking place so quickly that it is not possible to assess their net impact on mobility.

Availability and use of the Internet in the Netherlands

With 89% of Dutch households having an Internet connection (Eurobarometer, 2012), the Netherlands plays a leading role in Europe in this field. In 2011, 86% of Dutch Internet users were online every day or almost every day. In 2005, this was 68%. In 2011, the Internet is still most used at home. In 2011, half of all Internet users have Internet access through mobile devices such as a laptop, a Smartphone or a tablet. This share is growing rapidly. Especially young adults use tablets often on the road or at other locations, such as school and work. Several Internet activities are now quite well established, such as Internet banking. The Dutch are among the most frequent on-line shoppers in the world (*Source*: Eurobarometer, 2012). The most important Internet activity is communication; the Internet is also widely used as an information source.

Types of e-activities

The number of activities that can be performed over the Internet is growing rapidly. We focus here on those activities for which a sizeable impact on mobility can be expected: shopping, working, banking, meetings and leisure activities.

E-commerce is nothing else but buying and selling of goods through the Internet. This can be a selling process between businesses and consumers (web shops), but also between consumers (for instance, through eBay). The shopping process has changed due to the Internet. The strong increase in sales through the Internet does not necessarily mean that, for those specific transactions, no physical stores are visited. People often make their choices on the Internet, visit the physical store to check whether the chosen product fits their requirements and make the actual purchase through the Internet (I&O Research, 2011). Sites like eBay.com have created a new market, where consumers can easily buy and sell secondhand products. Research shows that 46% of these transactions would not have taken place without the Internet (Weltevreden *et al.,* 2009).

The number of Internet purchases is increasing very fast. Now, nearly 10% of all shopping in the Netherlands is done through the Internet (I&O Research, 2011). For daily shopping, the share is still limited. The Dutch mainly buy books, clothing and sports gear through the Internet; they also book transport tickets, holidays and accommodation. The number of orders that consumers place on the Internet is increasing, as well as the average amount of money spent annually on Internet purchases (890 EUR in 2011). The most important reasons for purchases through the Internet are ease, flexibility and speed of delivery. Having a preference for traditional shopping appears to be the most important reason for not shopping online. In particular, young people consider e-shopping to be a social activity.

E-working renders working activities flexible in space and/or time: working at home for a day, working in a "flex-office" or working in any other location providing the necessary facilities. Another option is to work at home part of the day, to avoid peak hour traffic. In 2010, just over a quarter of the Dutch workforce worked at home for part of their working hours (> 1 hour a week). This share has been quite constant over the last few years. The number of hours working at home has shown a small increase, from an average of 5.5 hours a week in 2005 to 6.2 hours a week in 2010 (CBS, 2012). The possibilities to work at home strongly differ among sectors, types of job, age groups and genders. Most work at home takes place in sectors like education and financial services. For people working in

sectors such as building and the hotel and catering industry, working at home is difficult and, therefore, very rare.

Internet banking is the performing of several banking activities from home through the Internet. The introduction of Internet banking offered the opportunity to undertake traditional banking activities (make payments, open and close accounts, buy shares, etc.) at any moment of the day and during the weekends. With 11 million Dutch citizens using Internet banking in 2011, it has been fully adopted by society (Eurobarometer, 2012). In 2012, all major banks have introduced applications for Internet banking via mobile devices, which means that banking has become "footloose".

E-conferencing is using a real-time connection between two or more business partners. This can either be by telephone or by video connection. When the Internet is used, the procedure is called Web conferencing. The market for e-conferencing has grown strongly over the last 20 years as a result of cheaper platforms (PC and Web-based) for video conferencing. Fifteen per cent of all Dutch employees state that they take part in virtual meetings (Ruigrok, 2011); and 68% of business air passengers state that they have access to videoconferencing in their company (Denstadli *et al.,* 2012). The availability of video conferencing differs by sector. It is specifically available in the financial world and in the high-tech industry.

E-leisure. There are many (social) leisure activities that fit under this umbrella. For many leisure activities, such as visiting the zoo, a museum or a party, no virtual alternative is available. In this case IT plays a role only in arranging such leisure activities. Here we focus on activities in which IT plays a certain role, for instance making contacts and communicating with friends through social network sites (Facebook, Hyves, LinkedIn), online and/or mobile gaming, listening to music (Spotify) and watching films through the Internet (YouTube, video on demand). These ways of spending leisure time have quickly become popular in the Netherlands and are much used. An illustration: Facebook registered 8.8 million visitors in the Netherlands in March 2012 (two-thirds of all the Dutch who are "on line"), while the figure was 6.6 million in April 2011 (Marketingfacts, 2012).

E-mail is fully utilised in the Netherlands, with a participation rate for all age groups of well over 90%. More than half of the Dutch population visits social network sites and about one-third exchange text messages, chat or read blogs. Among young people between 16 and 25 years old, social network sites and the exchange of text messages are very popular. This type of (social) leisure-time spending has penetrated much less into the higher age groups. It is not known whether this has to do with age or with the increasing possibilities of IT over the years (www.cbs.nl).

Effects of e-activities in general

To gain a better insight into the effects of e-activities on mobility, a distinction among four different kinds of effect is useful (Mokhtarian, 2002):

- *Substitution effect*: A location-based activity is replaced by an IT-based counterpart, as a result of which physical mobility is (partly) replaced by virtual mobility; an example is working independently of time and place instead of working in an office.

- *Complementarity effect:*
  - ✓ *Generation effect*: Use of IT leads to new location-based activities, which would not have occurred without the use of IT; therefore, extra mobility is generated. An example is a coupon received by e-mail that encourages the consumer to visit a physical store to get a discount on certain goods.

- ✓ *Efficiency effect*: The use of IT for an activity is directly linked to an activity at another location because of efficiency purposes at such a location, leading to an increase in mobility; an example is the retrieval at a post office or physical store of products purchased through the Internet.

- *Modification or adjustment effect*: The use of IT leads to an adjustment of mobility, but does not replace, stimulate or eliminate it. An example is the adjustment of a departure time or a route as a reaction to the receipt of travel information (through the use of IT).

- *Neutrality effect*: The use of IT has no impact on other activities and related travel. Examples are online gaming, impulse purchases over the Internet and online music sharing.

In many studies, only the substitution effects are considered.

Mobility effects of specific types of e-activities

E-commerce

Buying through online shops leads to different, contradictory effects on mobility. Sometimes mobility is directly reduced, for instance, when a holiday is booked through the Internet instead of at a travel agency. Sometimes the e-shopping generates physical mobility, for example, when the consumer receives coupons by e-mail, which he or she needs to spend at a physical store. Physical shopping can also be a necessary part, or a side-effect, of online shopping, for example, when products bought online need to be picked up and/or must be paid for at a physical store. Products that are purchased through the Internet, but would not have been bought without the Internet, do not affect the mobility of persons.

Shopping on the Internet also has an impact on freight traffic. Consumer products purchased on the Internet usually need to be delivered to the home address. What the impact is varies by type of product. Nearly 80% of all online purchases generate a freight movement, either with a delivery at home or at the working address (Weltevreden and Rotem-Mindali, 2009). About 10% of online purchases are picked up by the consumer at a post office, a delivery point or a shop. In these cases, there is thus both passenger and freight mobility involved. Products such as tickets and music are digitally delivered (7%); in this case, no physical mobility is involved.

In general, e-shopping leads to a slight decrease in the number of trips and the number of kilometres in personal mobility and to a slight increase in freight movements and kilometres. E-commerce between individuals (C2C commerce), for example, through sites like eBay, lead to a greater number of trips and a higher number of kilometres. This applies to both passenger and freight transport (Weltevreden and Rotem-Mindali, 2009). This is partly because impulse purchases are involved (50%), which normally would not have been made, partly because consumers pick up the goods from people who live further away than the store where they would have normally bought it, and partly because the purchase involves a parcel service delivery.

E-working

E-working also has several conflicting effects on mobility. Its primary effect is a substitution effect, whereby the physical commute is replaced by telecommuting. In the second place, there can be a modification effect. When travel and/or working hours are adjusted and/or activity chains changed (for instance, getting the children from school first and work some extra hours in the evening), overall

mobility remains equal. This modification effect can still be felt on the road, because the mobility is better spread over the day (Ministry of Infrastructure and the Environment, 2011). E-working can also lead to an increase in mobility. For instance, when the car of the person working at home is, meanwhile, used by another member of the household (generation effect) for other types of trips (care, shopping…). Little is known, therefore, about the net impact of e-working on mobility.

Internet banking

Mainly involves substitution effects. The physical visit to the bank is replaced by a virtual visit. However, the decrease in personal mobility is limited, as in the past people rarely went out only to visit the bank. Such a trip was usually combined with other shopping activities.

E-conferencing

Face-to-face meetings and video conferencing serve different purposes and, therefore, complement each other. Face-to-face meetings are especially suited to create confidence, to negotiate and (for first time meetings) to get acquainted. Videoconferencing is usually chosen for an exchange of information, project activities, contact with (international) headquarters and follow-up conversations. Therefore, there are mostly neutrality effects involved and only limited substitution effects. When substitution is at all involved, this mainly concerns (international) air travel (Denstadli *et al*., 2012). At a maximum rate of application, e-conferencing is estimated to be able to replace about 5 to 17% of international business air travel (Mensink, 2010). However, e-conferencing also has a limited generation effect, because of the generated need to have occasional physical meetings. No information is available on the substitution effects of video conferencing on Dutch (car) mobility.

E-spending on leisure time

Very little is known about the effects of e-spending on leisure time. Recent empirical studies do not indicate a substitution effect (Andreev *et al.,* 2010). Social network activities through the Internet mainly facilitate the maintenance of existing contacts (Boyd and Ellison, 2007; Ellison *et al.,* 2007). Social contacts through the Internet could possibly lead to fewer trips with a social purpose (Veldkamp, 2012). Besides this, there could also be a limited generation effect, because of the wish to physically meet people who one has contacted through the Internet. However, the size of this effect is unknown. Finally, IT can also have modification effects ─ for instance, by means of mobile devices, the time and location of meetings can quickly be changed and communicated.

Conclusion

It is certain that the increasing digitisation of society has an impact on mobility. However, from the available literature and data, it is often difficult to deduce how large the net impact is.

A straight answer to the question whether IT has an impact on mobility cannot be given. As shown above, the various e-activities have different effects on mobility. Virtual activities may either lead to a decrease in mobility, an increase of mobility or an indifferent effect on the volume of mobility, and can have side-effects in terms of shifting the volume in time (for instance, from a peak to an off-peak period). Table 5 shows the different types of e-activities and summarises the effects on mobility that can be expected.

Table 5. **Expected effects on mobility from different types of e-activities**

Type of e-activity	Substitution	Neutrality	Modification	Generation	Efficiency
E-working	X		X	X	
Business to Consumer e-commerce	X	X	X	X	X
Consumer to Consumer e-commerce	X			X	
Internet banking	X				
E-conferencing	X	X		X	
Leisure time spent on Internet	X		X	X	X

We cannot offer a conclusive explanation for the observed stabilisation in car mobility resulting from increased e-activities. To be able to establish the impact on car mobility of the e-society, more research is needed.

In addition, it is interesting to note that we are in the middle of fast-changing IT capabilities. The use of mobile devices (Smartphones and tablets) is growing very rapidly. Unlike Internet on fixed PCs, mobile Internet will ensure that activities can really be carried out "footloose": it enables constant adjustments of activity patterns and associated transport activities and enables 24-hour contact between individuals. The expectation is that the impact of IT on mobility will further increase in the future.

4.5 Increased international mobility of the Dutch population

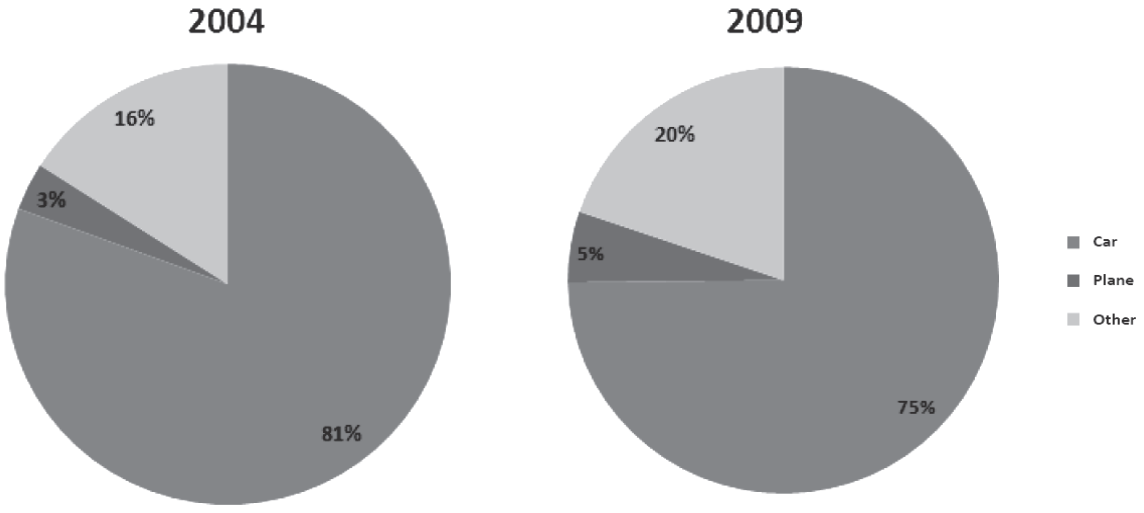
Strong increase in trips abroad, but they are modest in number

The Dutch are increasingly travelling abroad, not only to go on holiday, but also to work, to visit family and friends or to stay in their second houses somewhere in France or Spain. During the time that we are abroad, we cannot make any trips in the Netherlands. The levelling off of the growth in car mobility might have something to do with the increase in international travel, whether by car, train or plane. The international mobility of the Dutch population was analysed using data from the Continuous Holiday Survey (CVO) for 2002 to 2011 and the Mobiliteitsonderzoek Nederland (MON) for 2004 to 2009. This means that not all foreign mobility is in this analysis. Business travellers, students who study abroad for longer periods, expatriates, and retired people staying in southern Europe during the winter, are examples of groups that are not in the analysis. Similarly, the mobility of foreigners in the Netherlands is not part of the analysis, because of a lack of information regarding such groups.

The total number of trips made by the Dutch population that cross the border is estimated to have increased by around 18% between 2004 and 2009, while their trips on national soil have hardly changed during the same period. Together, the Dutch made around 150 million trips abroad in 2009, which is about 2% of the total of national trips (excluding the bicycle and walking).

About 88% of the trips to and from abroad concern daily international trips for work, shopping, studying, etc. Two thirds of these trips are shorter than 50 km. The favourite destinations for daily activities are Belgium and Germany. The daily trips are mainly made to visit our neighbouring countries for leisure activities and, to a lesser extent,* for work, education or shopping. The car is the favourite mode (see Figure 15). Over the years, the proportion of car use for shopping and leisure has declined at the expense of other modes of transport: the plane and train have become more important. Perhaps the introduction of fast trains (ICE and TGV) has been of significance here. For work-related trips, the share of the car has been more or less constant.

Figure 15. **Mode distribution for Dutch trips abroad (excluding holidays)**

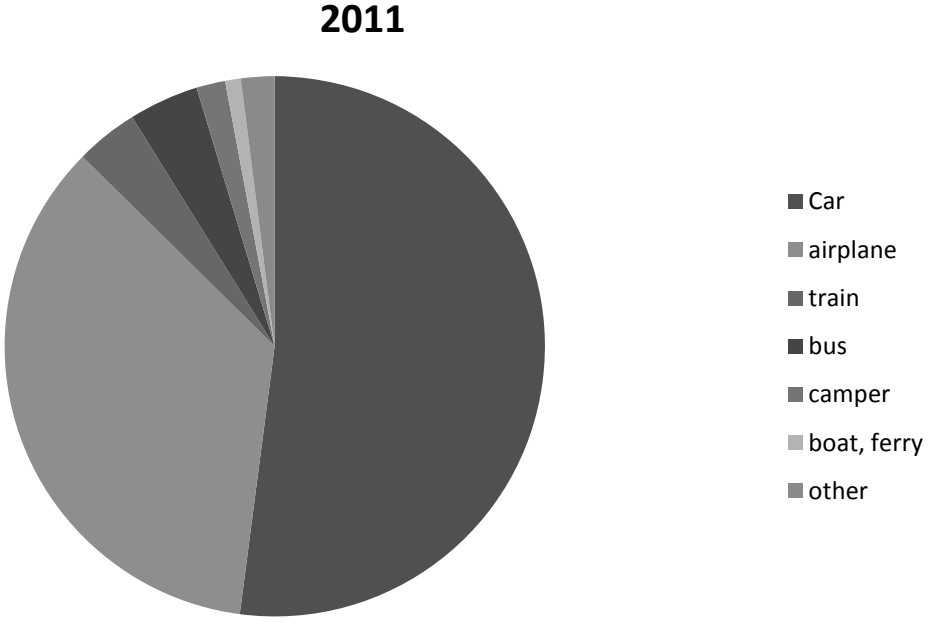


Strong increase in kilometres travelled during holidays
Source: KiM based on MON-data.

The remaining 12% of the international trips are for holidays (defined as a stay abroad of three days or longer). The number of foreign holiday trips increased by 11% between 2002 and 2011; the number of kilometres involved increased by 34%. Nowadays, a Dutch holiday trip involves, on average, around 3 500 kilometres (return distance). In total, in 2011 the Dutch travelled about 65 billion kilometres for foreign holidays, which is 34% more than in 2002. Measured in kilometres, this is approximately equal to one-third of the total domestic mobility. Foreign holiday destinations are further away and the stay abroad is longer than for non-holiday activities. On average, a trip lasts ten days per person. This duration of the foreign trip has not changed over the last ten years. However, because they take a holiday more often, the Dutch on average stay abroad slightly longer than ten years ago.

For holidays abroad, the plane is becoming more and more important (see Figure 16). In ten years' time, its share in holiday trips has increased from 25 to 35%. Measured in kilometres, the share grew from 59% in 2002 to 71% in 2011. The rise of the plane was at the expense of the car, which saw its share in longer holiday trips decline.

Figure 16. **Mode distribution for foreign holiday trips by the Dutch population**



However, it is interesting to see that, although the car is used less to travel to the holiday destination, in the case of about 11% of holidays abroad, a car is hired locally. With these cars, the Dutch travel on average about 1 150 kilometres during their trip. People who use their own car for the holiday trip on average drive about 440 kilometres around their holiday destination (Peeters *et al*., 2010). This represents extra Dutch car mobility during holidays of around 5 billion kilometres, or about 1% of domestic car use.

Regarding foreign holidays, Germany has overtaken France as the favourite holiday destination. Traditional destinations such as the Ardennes and Luxembourg have lost importance. The destinations in the sun have shifted somewhat further away; somewhat fewer Greek destinations in favour of Turkey and Egypt; somewhat fewer to the Costa Brava and more to the Algarve. More exotic destinations in Asia, Africa and South America have seen a strong growth, as have visits to Indonesia and the Netherlands' Antilles. There are strong fluctuations in destinations from year to year, which may be due to regional social unrest or natural disasters.

Conclusion

In recent years, the international mobility of the Dutch has significantly outpaced growth in mobility within the Netherlands. However, the contribution to explaining the slowdown in the growth of domestic car mobility has been limited. This is because the total volume of international trips relative to those in the Netherlands is small ─ about 2% (not including walking and cycling).

4.6 Synthesis: Causes of the levelling off in car mobility

Based on an inventory of the kinds of driver considered in research in other countries, and based on the analysis of developments in the Netherlands, we have considered the following four possible explanations for the levelling off in car mobility:

1) Possible signs of saturation in direct influencing factors;
2) Changing mobility of young adults;
3) The rise of the Internet society;
4) Increased international mobility of Dutch inhabitants.

Saturation in direct influencing factors: limited contribution

Between 2000 and 2010, persons between 18 and 29 years have contributed considerably to the reduction in car use. Unlike other western countries, in the Netherlands there has been little effect through changes in direct influencing factors such as car ownership, driver licence holding or income. These factors appear to play only a minor role in the explanation for the levelling off in car mobility. An exception is the development of labour participation by women. After a strong increase, this has stabilised since 2008; from that year, a slight decrease in men's labour participation can be seen. All in all, the contribution of possible saturation phenomena appears to be limited.

Changing mobility of young adults: substantial contribution

The (car) mobility of young adults has decreased sharply since 1995, both in terms of the number of trips and the number of kilometres travelled (also when the changes in size of this age group are taken into account). Usual factors, such as holding a driver's licence and car ownership, changed very little over time and offer no adequate explanation for the decrease. The employment rate among young women has reached a ceiling and may have had some influence. The number of young working adults has declined, while at the same time many more of them participated in higher education. This process went hand-in-hand with a substantial shift towards living in high-density urban areas. Combined with the lower car ownership levels in this group, this has led to fewer work-related car trips. Although much quoted in publications on reduced car mobility, a significant change in the attitudes of young adults could not be determined. The possible impact of such a trend remains unclear. The same applies to the impact of the increasing use of social media and smart phones, which could not (yet) be established.

The rise of the Internet society: possible contribution, not to be determined

Many expect that changing different types of physical activity into virtual activities has led to a decrease in (car) mobility. This will certainly have been the case, but these developments in e-activities also generate new activities, with associated mobility. The strong growth in e-commerce has had an effect on the number of (shopping) trips, the kilometres travelled and the number of trips and kilometres involved in deliveries. For the time being, it remains unclear the extent to which this has led to a substantial contribution to the levelling off of car mobility. This also holds for the introduction of e-working and the use of social networks for leisure activities.

Increased international mobility: limited contribution

In recent years, the international mobility of the Dutch has significantly outpaced mobility growth within the Netherlands. However, the contribution to an explanation for the slowdown in the growth of domestic car mobility is limited. This is because the total percentage of international trips relative to those in the Netherlands is small ─ about 2% (not including walking and cycling).

5. Implications for policy development and associated research questions

The levelling off of car mobility in the Netherlands and the findings from the analysis of the causes of this phenomenon carry certain implications for policy development and research.

5.1 The need to deal with an even more uncertain future

A first policy implication is related to the question of whether the levelling off of car mobility in the Netherlands is a phenomenon that will continue, because of systematic "new" developments which were never before acknowledged, or whether it is just a temporary development caused by "normal" fluctuations in demand over time. The answer to this question could be of major consequence for policy development in terms of the need for extra infrastructure capacity and the associated funding.

From the analysis, it is clear that some of the causes found are already taken into account in the long-term scenarios for the development of road traffic, which are currently used by the Ministry of Infrastructure and the Environment in programme and project assessments (Ministry of Infrastructure and the Environment, 2011b). Examples of this are changing car ownership levels, demographic change and spatial distribution of houses and working locations. A difference with these projections might be that some of these developments have manifested themselves somewhat earlier than previously expected. However, this should not have a strong impact on long-term projections.

Little contribution to the levelling off of car mobility could be determined from the analysis of other causes studied. Either the contribution was very modest or it was not possible to determine a contribution because of lack of data. This implies an (extra) uncertainty for the existing projections for future developments.

Another issue is the economic crisis, which somewhat "troubles" the analysis, but must have had a downward effect on car use over the last few years; but it can lead to an increase in car mobility when the economy starts to grow again. Based on this and on the fact that traffic volumes are also influenced by predicted increases in freight volumes, it is not to be expected that the development in road traffic will move out of the bandwidth of current projections. These projections show modest to moderate growth in traffic volumes over the next decades. However, it can be concluded that the development will most probably be close to the lower bound of the bandwidth (modest growth).

The high uncertainties should be an extra impulse for policymakers to focus on low-growth, in addition to the more common high-growth, scenarios. From a policy point of view, this suggests that, in policy development, more attention be given to adaptive strategies, to avoid the supply of costly overcapacity in the transport system.

A related research question here is: What instruments are available and can be applied for designing adaptive policies?

More policy attention for groups

The analysis of the levelling off of car mobility shows rather large differences in the development of mobility behaviour in different segments of mobility (age groups, trip purposes). These differences suggest that more specific attention be given to differences between groups in the policymaking process.

Specific research questions here are: What effect could changing preferences towards the car among young adults have on policymaking? What can be expected regarding the future mobility behaviour of current young adults? and to what extent does the current mobility behaviour of young adults influence the behaviour of other age groups?

Changing travel patterns require a more robust transport system

A more adaptive policy regarding the supply of infrastructure will undoubtedly lead to a system that makes better use of existing capacity and will have less overcapacity. However, in society we also see a very fast penetration of mobile Internet devices, such as smartphones and tablets. These devices enable the traveller to respond very quickly to activities or events which he/she would otherwise not have noticed. The total transport system (with little overcapacity), will have to be able to cope more and more with such new types of fluctuations in demand. This requires extra policy attention for network management aimed at providing robust system solutions.

Focus on re-urbanisation

The analysis shows that part of the explanation for the leveling off of car mobility is related to the process of reurbanisation. This process will come with an increased number of trips related to the high-density urban areas. This may require specific policy attention for the interactions between local and national infrastructure networks.

Related research questions are: To what extent will the reurbanisation trend continue; and what does it imply for the position of various travel modes within the mobility system?

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Long Run Trends in Car Use

The growth of car use in several advanced economies has slowed down, stopped, or turned negative. The change cannot be attributed to adverse economic conditions alone. Socio-demographic factors, including population ageing and changing patterns of education, working, and household composition matter. Rising urbanization and less car-oriented policies in some cities also reduce the growth of car use, perhaps combined with changing attitudes towards mobility. Some groups choose to use cars less, others are forced to.

This report summarizes insights into the drivers of change in car use. It shows that explanations are place-specific, and that projections of future car use are increasingly uncertain. The task for policy-makers is to identify mobility strategies that are robust under an increasingly wide range of plausible scenarios.

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