Land Use, Planning and Infrastructure Issues in Transport

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1. Introduction

There has been much debate over the importance of land use, urban form and development in determining the use of different forms of transport and the subsequent use of energy and the emissions created. Much of the literature states that there is a clear link, but there is little empirical evidence available to support these assertions. Much of the evidence that is available is rather dated and needs to be rerun with the latest NTS data to establish more recent trends and the changes over time (see Appendix 1). It is accepted that the urban built form changes slowly at between 1-2% per annum (Banister and Hickman, 2006), but over time significant change does take place – certainly within the time horizon for action on climate change - and over 80% of the UK population now live in urban areas. More important is the real concern over new construction that may be building in high levels of transport activity, with consequent implications for energy use and carbon emissions, and this in turn will reduce the effectiveness of the sustainable communities programme and the contribution that land use and planning can make to overall carbon reduction targets.

This paper outlines the key relationships between transport and density, settlement size, mixed use development, the concentration of activities, and local issues relating to neighbourhoods. From this review a series of key principles are highlighted to reduce travel distance by land use and planning interventions. The second part of the paper then explores the wider decision making context at the strategic and local levels, including barriers to change and the links between the physical built environment and behavioural questions relating to choice (see Phil Goodwin's paper). It also briefly refers to the parallel discussions in freight. The final part of the paper identifies key questions for further work, including the difficult issues of measuring the potential impact and then relating this to carbon abatements costs. The main focus is on reducing trip distance, as this is the main potential for land use to contribute to reductions in greenhouse gas emissions in transport.

2. Key Relationships

A substantial amount of research has tried to establish links between travel, land use and urban form. This ranges from simple analyses of trip generation and attraction characteristics of particular land uses (e.g. residential and shopping) to more detailed analyses of travel (and energy use) in locations with distinctly different characteristics (Table 1). The verdict on this empirical work is mixed. For example, Anderson et al (1996) concluded that the current level of understanding of the influence of urban form on the generation of emissions and the use of energy is weak. But others (e.g. Stead, 2001 and Hickman, 2007) have found far more significant relationships between land use and transport (Table 2). In both these cases, the socio economic variables explain substantially more of the variation in trip making activities than the land use factors.

Table 1: Links between Land Use and Transport

Urban Form Variables
1. Settlement Size
▪ No correlation between urban population size and modal choice in the US (Gordon et al., 1989a and b). ▪ The largest settlements (>250,000 population) display lower travel distances and less by car (ECOTEC, 1993). ▪ The most energy efficient settlement in terms of transport is one with a resident population size of 25-100k or 250k plus (Banister, 1997).
2. Density
▪ Increasing densities reduces energy consumption by transport (Newman and Kenworthy, 1989a, 1989b, 1999). ▪ There is no clear relationship between the proportion of car trips and population density in the US (Gordon et al., 1989a and b, 1991). ▪ As densities increase, modal split moves towards greater use of rail and bus (Banister et al., 1997). ▪ Compact cities may not necessarily be the answer to reducing energy consumption, due to effects of congestion, also decentralisation may reduce trip length (Breheny, 1997, 2001: Gordon and Richardson, 1997). ▪ Decentralised concentration is the most efficient urban form in reducing car travel (Jenks et al., 1996). ▪ Density is the most important physical variable in determining transport energy consumption (Banister et al., 1997). ▪ Higher densities may provide a necessary, but not sufficient condition for less travel (Owens, 1986). ▪ As people move from big dense cities to small less dense towns they travel more by car, but the distances may be shorter (Hall, 1998).
3. Jobs-Housing Balance and Mixed Use Development
▪ Communities are balanced where the ratio of jobs to housing units lies in the range of 0.75 to 1.5 (Breheny, 1995). ▪ Local facility provision does not determine modal choice, personal and household

characteristics are the main determinants (Farthing et al., 1997). ▪ Diversity of services and facilities in close proximity reduces distance travelled, alters modal split but people are prepared to travel further for higher order services and facilities (Banister, 1996).
4. Location, Accessibility and Neighbourhood Design
▪ Location of new housing development outside existing urban areas, or close to the strategic transport network, or as free-standing development increases travel and influences mode split, and can lead to "stretch" commuting (Headicar and Curtis, 1998). ▪ Location is an important determinant of energy consumption and car dependency (Banister et al., 1997). ▪ Development close to existing urban areas reduces self-containment and access to non-car owners (Headicar, 1996). ▪ Urban design quality: some evidence in the US shows the differential impact of new urbanism versus cul-de-sac route networks on travel behaviour. Some initial evidence in the UK (Boarnet and Crane, 1999; Marshall, 2001; Hickman and Banister, 2005).
Wider Socio-Economic Characteristics.
▪ Increased household size, income and car ownership are associated with increased trip frequency (Hanson, 1982). ▪ Car ownership is associated with increased travel distance, proportion of car journeys and transport energy consumption (Naess, and Sandberg, 1996). ▪ Dual-income households: the choice of new housing location is influenced by the location of two workplaces. The extent of "excess travel" and the reasons behind this phenomenon are not well researched. Travel time is more important than travel distance, and the role of the travel factor in the choice of a new home location seems to be important (Ma and Banister, 2006) ▪ Attitude: some research in California, US as to the impact on travel behaviour, which suggests it may be a more important factor than land use and other socio-economic variables. Early research available from Surrey, UK (Hickman, 2007).

Based on Banister, 2005 and updated to 2007.

Table 2: Explanation of travel from land use factors

Stead (2001) – The most extensive UK study used regression analysis on NTS data. Here, it was concluded that socio-economic factors are more important than land-use factors, explaining between 23-55% of the variation in the amount of travel by wards (there are some 8,400 wards in England) at the aggregate level. The most important socio-economic factors are car ownership, socio-economic group and employment. Land-use characteristics explain up to 27% of the variation in trip making – this includes density, settlement size , and public transport accessibility
Hickman (2007) and Hickman and Banister (2007) – Household data was collected from new developments in Surrey (1998). Land use and socio economic variables together explain 60% of the variation in the travel patterns of households, and individually the levels were 9% for land use and 28% for socio economic variables.

Note that the levels of explanation of the relationships between socio economic variables and land use variables and travel or energy use fall as the level of disaggregation increases, so higher levels are found at the regional and city wide levels – see Newman and Kenworthy's analysis below.

Three main elements need to be examined:

1. Density of development – has an important effect on the distances travelled, the modes used and the energy profiles. The most cited research here has been carried out over the last 15 years by Newman and Kenworthy (1989a and b, 1999) in their comparison of the transport energy profiles of 84 cities. Their powerful conclusion reached was that when urban density in the 58 wealthier cities was correlated with car passenger kms, urban density explained 84% of the variance (Kenworthy and Laube, 2001; Kenworthy, 2007). When energy use was correlated with activity intensity (persons and jobs per hectare), 77% of the variance was explained. Despite concerns over the methods used and the quality of the data, clear relationships have been established at the city level. A general conclusion is that an increase of 10% in local density results in a 0.5% decrease in vehicle trips and vehicle miles travelled (Ewing and Cervero, 2002; Table 4).

In Hong Kong, the role of land use in mode choice is clear due to the densely built environment. Empirical modelling confirmed that the role of land use in influencing travel was independent from travel time and monetary costs. Elasticity estimates show that the composite effect of land use on driving could be comparable in magnitude to that of driving cost. Land use strategies influence travel more effectively when complemented by pricing policies (Zhang, 2004).

Settlement size is also important in influencing both modal shares and the distance travelled (Tables A2, A3 and A4), as use of public transport and walking increases with population size (Dargay and Hanly, 2004). Diseconomies of scale may feed in with the largest cities, which have a complexity of movement that is substantially greater than the smaller monocentric cities – circumferential trips are as important as radial trips (Banister, 1997).

The US literature is also variable in its findings, as Ewing (1997) estimated that a doubling of density resulted in a 25-30% lower level of vehicle miles travelled (VMT), whilst Holtzclaw (1994) concluded that the difference between 20 dwellings/acre (urban densities) and 5 dwellings/acre (suburban densities) was a 40% increase in travel. Overall, the US evidence seems empirically powerful, suggesting that higher density developments can reduce VMT by at least 10-20% as compared with urban sprawl (Litman, 2007; Table 5).

2. Proximity and Quality – land use patterns in post industrial cities are changing as greater mixed use is the dominant feature. This means that journey lengths can be reduced through the use of local facilities and services. Considerable effort is now being placed in transport development areas (or the similar transit oriented developments in the US), where high quality public transport accessibility can be combined with office development, residential, leisure and retail activities, all in close proximity to each other. The importance of quality is paramount as these accessible locations become the centre of activity giving possible implications for public transport use. This is a concentration of activity that has beneficial impacts on modal split and the use of local facilities, but it needs to be balanced against the counter trend of dispersal (and sprawl) that has an opposite effect on trip lengths and a greater level of car dependence.

Cervero and Duncan (2006) examined the degree to which job accessibility is associated with reduced work travel and how closely retail and service accessibility is correlated with miles and hours logged getting to shopping destinations. Based on data from the San Francisco Bay Area, they found that jobs-housing balance reduces travel more, by a substantial margin, than accessibility to shopping. But they also concluded that it is important to look at access to public transport at both ends of the journey. By concentrating "housing near rail stops will do little to lure commuters to trains and buses unless the other end of the trip – the workplace – is similarly convenient to and conducive to using transit." (Cervero, 2006, p53).

3. Local Neighbourhood and Design – The new urbanism debate encourages more local activity through more walking, direct routing for slow modes of transport, and quieter and narrower streets (Duany and Plater-Zyberk, 1991, and Calthorpe, 1993). People Travel shorter distances when they move into neighbourhoods with higher accessibility (Krizek, 2003), with median distance increasing from 3.2km in the more accessible neighbourhoods to 8.1km in less accessible neighbourhoods. Street connectivity is also important here as it can reduce distances for slow modes, but cul de sacs are also popular with residents, even though they tend to extend travel distances. Main Street programmes in the US (and more recently in the UK) are intended to revitalise town centres by restricting access at certain times and to create vibrant communities day and night (Handy, 2004). Other initiatives to encourage urban living include extensive pedestrianisation, the closure of residential streets, gated communities, and even the removal of freeways (e.g. the Embarcadero Freeway in San Francisco). The issue of parking management is central here.

One of the few detailed empirical studies has been carried out in Toronto (Norman et al., 2006) for city centre apartments (net residential density 150 dwellings/hectare) and suburban detached housing (net residential density 19 dwellings/hectare). Although the GHG emissions and energy density were similar per unit of living space (m^2) for construction materials, building operations and transport, the figures per person are very different (Table 3). This is due to the additional space available per person in the suburban detached housing. The GHG emissions are 2.5 times higher in the suburban than the urban housing. For transport, the figures are stark, with GHG emissions (and energy use) being more than 3.5 times as high in the low density housing for car and 6.5 times as great for public transport. Although the densities used in the Toronto study are different to those used in UK cities, where gross densities average about 20-40 dwellings/hectare (net densities 80-160 dwellings/hectare[1]). For example, the average Inner London (20% of area) gross density is about 45 dwellings/hectare, and that for Outer London (80% of area) is about 15 dwellings/hectare, a 3 to 1 ratio (Banister, 2007).

Table 3: GHG Emissions for Different Housing Types in Toronto

Annual GHG Emissions – kg CO_2eq/person/year in 1996	Suburban Detached	%	Urban Apartments	%
Construction	597	7	391	12
Building operations	2730	32	1510	45
Car travel	5180	60	1420	43
Bus transport	130	1	20	-

Based on Table 4 in Norman et al. (2006)

A large sample of the Great Britain National Travel survey was taken by Dargay and Hanly (2004) for 1989-1991 and for 1999-2001 to test for the impact of land use characteristics on the level of mobility and the use of cars. They concluded that land use characteristics (population density, settlement size, local access to shopping and other facilities and accessibility of public transport) play a significant role on car ownership and use of the car. Density has a greater impact than settlement size, and proximity to local facilities encourages walking instead of car travel.

4. Cumulative Effects – Land use effects on travel behaviour tend to be cumulative and mutually reinforcing (Hickman, 2007; Litman, 2007). This effect can be illustrated in two ways. Ewing and Cervero (2002) calculated the elasticity of vehicle trips and travel per capita with respect to four land use variables (Table 4). Their estimates suggest that a doubling on local density reduces car trips by 5% per capita and travel by about the same amount. Although the elasticities are low, Ewing and Cervero (2002) concluded that they were cumulative, thus giving the potential for 13% and 33% decreases in trips and trip distance respectively.

[1] The relationship between gross and net density is not a simple one, as net density excludes open space (public and private), roads, parking and footpaths. Buildings normally occupy 20-30% of the total site area, so the ratio would be between 3 and 5 to 1.

Table 4: Elasticities of Trips and Travel by Land use Factors

Factor	Description	Trips	Travel (VMT)
Local density	Residents and employees divided by land area	-0.05	-0.05
Local diversity	Jobs/residential population	-0.03	-0.05
Local design	Sidewalk completeness/route directness and street network density	-0.05	-0.03
Regional accessibility	Distance to other activity centres in the region	-	-0.20

Source: Ewing and Cervero (2002)

The second study was by Lawton (2001) using data from Portland Oregon to examine the impact of land use density, mix, and road network connectivity on personal travel. As urbanisation increases, per capita vehicle travel declines significantly from about 20 average daily travel miles per adult (32kms) to just over 6 miles (10kms).

The main conclusions with respect to the impacts of the land use factors on travel distance are (Hickman and Banister, 2005):

1. At the regional level, the location of new development, particularly housing, should be of a substantial size and located near to or within existing settlements so that the total population is at least 25,000 and probably nearer to 50,000. The provision of local facilities and services should be phased so as to encourage the development of local travel patterns.
2. Density is important and average journey lengths by car are relatively constant (around 12km) at densities over 15 persons per hectare, but at lower densities car journey lengths increase by up to 35%. Similarly, as density increases, the number of trips by car decreases from 72% of all journeys to 51%. Car use in the high density locations is half that in the lowest density locations.
3. Mixed use developments should reduce trip lengths and car dependence. Although research here is limited and concentrates on the work journey, there is considerable potential for enhancing the proximity of housing to all types of facilities and services.
4. As settlement size increases, the trips become shorter and the proportion of trips by public transport increases. Diseconomies of size appear for the largest conurbations as trip lengths increase to accommodate the complex structures of these cities.
5. Development should be located near to public transport interchanges and

corridors so that high levels of accessibility for all can be provided. But this may also encourage long distance public transport commuting. Free flowing strategic highway networks are likely to encourage the dispersal and sprawl of development and stretch commuting.

6. The availability of parking is a key determinant of whether a car is used or not and further research is required to determine appropriate standards linked to accessibility levels.

These points are well summarised (Table 5) by Litman (2007), who concludes that in the US a 10-20% cumulative total saving in VMT is possible through density and mixed design, and a further 20-40% is possible form regional decisions on the location of new development. The figures in the UK are likely to be less, as the trip distances travelled are lower and there is already a much greater use of land use and development controls than in the US.

Table 5: Land Use Impacts on Transport – US Evidence

Factor	Definition	Travel Impacts
1. Regional Accessibility	Location of development relative to regional urban centres	Improved accessibility reduces per capita vehicle mileage. Residents of more central neighbourhoods typically drive 10-30% fewer miles than urban fringe residents.
2. Density	People or jobs per unit of land area	Increased density tends to reduce per capita vehicle travel. Each 10% increase in urban densities typically reduces per capita VMT by 1-3%.
3. Mix	Degree that related land uses are located close together	Increased land use mix tends to reduce per capita vehicle travel and increase the use of alternative modes, particularly walking. Neighbourhoods with good land use mix typically have 5-15% lower vehicle miles.
4. Public Transport Accessibility, Walking and Cycling Conditions	Quality of public transport and degree to which destinations are accessible; Quantity, quality and security of walking and cycling	Residents with good access to public transport tend to own 10-30% less cars, drive 10-30% fewer miles, and use alternative modes 2-10 times more frequently than residents in car oriented developments. Residents in more walkable communities walk 2-4 times as much and drive 5-15% less than if they lived in more car oriented developments.
5. Centredness, Network Connectivity, Design and Management of Routes	Location of employment in major activity centres, connectivity of the network (including density), design and layout of streets	Typically 30-60% of commuters to major commercial centres use alternative modes, compared with 5-15% of commuters at dispersed locations. Better road connectivity can reduce vehicle mileage and better cycling and walking provision also helps these

		modes. More multi modal streets improves use of alternative modes, with traffic calming reducing car use and increasing walking and cycling.
6. Parking Supply and Management and Site Design	Number of spaces per unit area, costs, time limits and management, and layout considerations	Parking management strategies can significantly reduce car ownership and mileage. Cost recovery pricing reduces car trips by 10-30%. Mobility management can also reduce car trips by 10-30%.

Based on Liman (2007), Table 21.

The recent McKinsey report (December, 2007) set a carbon abatement cost at $50 per tonne CO_2e, and concluded that the US can reduce their emissions by between 3.0 and 4.5 Gt CO_2e by 2030 (31% to 49% reduction). About a third of this figure would come from action on the built environment (buildings) and transport, but it was assumed (p42) that there was no change in consumer utility, and urban design, denser and more transport efficient communities were not assessed. It was also expected that there would be significant increases in distances travelled in the US over the period 2005-2030. The evidence cited here suggest that behavioural change and land use and development decisions can all have a substantial influence on travel and energy use, and can contribute to reductions in CO_2 emissions.

3. Freight

Two major land use factors influence the efficiency of freight operations, namely handling factors and the average length of haul. They both relate to the distribution networks, as they look at cutting the number of separate journeys made from source to consumption, which in turn reflects the amount of outsourcing and vertical disintegration that has taken place in this sector. McKinnon (2007) concludes that transport cost increases would have to be "very large to induce such a structural change" (p21). The use of consolidation points to assemble loads into larger units to save vehicle mileage and improve load factors (including reducing empty running) would be the aim of any such reorganisation, but there is little information that links these individual movements to overall supply chains.

The empirical evidence shows a substantial increase in UK freight haulage lengths, with the centralisation of production and the widening of supply chains, but this trend has stabilised recently (1953-2004 72km to 117 km for all freight; 35km to 87km for road freight). The extension of supply chains means cheaper production (in locations with cheaper labour costs), but less energy efficiency and longer journeys (so more CO_2/tonne km). McKinnon (2007) concludes that reconfiguration of production and distribution systems would require transport costs to be more than doubled. More local sourcing is also counter to global trends, but there is a need for full Life Cost Analysis (LCA) of CO_2 emissions. Spatial factors do affect the structure of the UK freight distribution system, with pricing and location decisions having a limited effect on reducing distances and improving load factors, but the scale of any intervention would have to be substantial to have a real effect. There does seem to be potential for action, but pricing along will not resolve the problem. There also needs to be clear statutory guidance on determining where new freight distribution centres are located to ensure that haul distances are minimised.

4. Decision Making and Assessment

Within the debate about sustainable communities, decisions need to be taken at all levels. The EU is giving greater guidance on the principles of sustainable development through their recent statement on urban mobility (CEC, 2007). The national government in the UK is responsible for overall planning policy, and this is changing with the current Planning Bill (2007) that will make some types of development easier. The key issue here is the location of new housing and other development in the UK, as this will have substantial implications for the levels of demand on the transport system, journey distances and the use of the different modes of transport.

At the regional and city levels, there are questions about density of development, the availability of land for infill or reuse, the extent of mixed use development, the shape and size of different settlements, and concentration and distribution of services and facilities. Local issues include neighbourhood design and quality decisions, including the layout of developments and the role for slow modes of transport.

In all cases, there is a need for all actors at all levels to work together across the different sectors so that sustainable development becomes a reality. Too often in the past decisions have been made in isolation, and it is often the transport system that has had to accommodate the additional demand for movement. There may now be an increasing realisation of this in decisions that people are now making in terms of where they choose to live. New lifestyle decisions mean that an urban location with shorter distances, good public transport and good accessibility to services and facilities become much more attractive. People do not like spending large amounts of time stuck in traffic.

For land use factors, the timing issue is important, and it is unlikely that a major contribution can be made to the first carbon budget period (2008-2012), but an increasing contribution can be made to the subsequent periods (2013-17 and 2018-22). At the strategic level, crucial decisions are now being made on the location of new housing and other forms of development that generate and attract substantial traffic. Eco towns and zero carbon settlements only work if transport is seen as being part of the design to encourage shorter journeys, less use of the car and greater use of public transport, walk and cycle. As noted in Section 2, this must include clear guidance on density, settlement size, provision of local services and facilities, mixed land uses, proximity to public transport accessible developments (Transport Development Areas or Transit Oriented Developments), and limited availability of parking. Best practice, benchmarking and strategic guidance would all help here.

At the neighbourhood level (and in city centres), design standards should be used to encourage ownership of the local environment by residents and other stakeholders, so that its quality is maintained and improved. Residential, shopping and even commercial space should be very clearly designated for different priority uses (perhaps varying by time of day – for schools, or day of week – for markets), so that people and slow traffic have priority. Similarly, local facilities and services raise levels of accessibility so that travel distances to shops, schools and health centres can be reduced. Through design it is possible to lock in the benefits of lower transport emissions levels.

5. Conclusions

Land use and planning both have much to offer in terms of improving city wide and local urban quality, in providing the opportunity for less travel by car, and in promoting the greater use of local services and facilities. By embedding best practice in the design of new development and ensuring quality is improved in the existing built environment, the costs of transport carbon abatement will not be high. The built environment is more significant than socio economic characteristics in explaining trip length, but less so when explaining trip frequency and modal choice (Ewing and Cervero, 2002). So it is important to calculate vehicle miles travelled. Enhanced accessibility may reduce the need to travel, but it may also increase the propensity to travel, so that the overall effect is more travel. Possible rebound effects need to be considered.

The basic question here is whether the investment (transport or urban development related) is going to reduce carbon emissions or raise it? This should include both the direct and indirect emissions. The buildings themselves might be efficient in carbon terms, but if the users of them (and their suppliers) make excessive use of polluting forms of transport, the benefits are eroded.

A total carbon costing approach would include both the direct and indirect factors. The indirect measurement would need to cover the numbers of trips (generated and attracted), the average trip distance and the mode used. The total travel can be converted into energy use and estimates of carbon emissions made (Banister, 1997 and Banister et al., 1997). The total energy and carbon used and produced by different types of development can be calculated, as demonstrated in the Toronto research (Table 3). This might provide a basis for bringing the non traded household and transport sectors into the traded carbon sectors.

The three main recommendations from this review are:

1. At the strategic level, the Great Britain National Travel Survey provides the strategic data necessary to establish the current situation and the historic trends in the links between travel patterns (trips, distances and modes used) and the basic list of land use parameters (Dargay and Hanly, 2004; Banister, 1997). Special tabulations may be required. The travel data would then need to be linked in with energy and emissions profile data to give estimates of the energy use and carbon produced.
2. At the local level, substantial empirical work is required to establish a database of different types of development in different locations and at different densities to establish the main parameters necessary to design in lower transport requirements. The TRICS database might provide a starting point here as it seems to provide the most comprehensive information on different trip generation and attraction rates for the full range of development types – there is data on over 2600 sites (http://www.trics.org/tricssystem.html).
3. From this review, it is difficult to come to definitive conclusions, but at the strategic level it is density and accessibility that would seem to be the most important land use and planning variables to monitor in terms of the transport related carbon emissions. At the local level, there is greater variability that relates to layout considerations and the quality of the local environment, as well as proximity (or closeness) to the full range of services and facilities.

Transport emissions can be reduced through lower emission rates per vehicle km or through reducing total vehicle travel (or a combination of both). Land use and planning can and should have a major role to play in achieving the second of these objectives.

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Appendix

Table A1: Travel Distance by Car Ownership and Density (1989/91)

Distance Km/person/week	0-1 pers/ha	1-10 pers/ha	10-20 pers/ha	20-35 pers/ha	>35 pers/ha	Total
0 Cars	82.0	89.4	73.2	83.3	93.0	86.2
1 Car	218.5	211.3	191.2	185.8	172.9	198.6
2 Cars	322.7	299.5	267.7	268.0	253.2	288.4
>2 Cars	324.9	332.4	267.5	305.1	264.8	311.0
All Households	220.7	218.0	181.9	180.6	158.8	197.3

Source: Based on Department of Transport (1995)

Table A2: Travel Distance by Settlement Size and Mode

	Kilometres per Person per Year - 1985/86			Kilometres per Person per Year - 1992/94			% Increase over 8 Years	
Settlement Size	Car (% of total distance)	Other	Total	Car (% of total distance)	Other	Total	Car	Total
London	5147 (63%)	3003	8149	5481 (67%)	2760	8241	6.5%	1.1%
>250,000	4933 (66%)	2504	7437	6445 (73%)	2356	8801	30.7%	18.3%
100-250k	6194 (72%)	2441	8636	8483 (80%)	2184	10666	37.0%	23.5%
50-100k	5919 (71%)	2369	8288	8291 (79%)	2210	10501	40.1%	26.7%
25-50k	6006 (73%)	2173	8178	7657 (78%)	2105	9762	27.5%	19.4%
3-25k	7144 (76%)	2369	9413	9498 (80%)	2445	11943	33.0%	26.9%
<3,000	8832 (78%)	2525	11357	11003 (82%)	2482	13484	24.6%	18.7%
Overall	6109 (71%)	2449	8558	7972 (77%)	2390	10362	30.5%	21.1%

Source: Stead (1996) and National Travel Surveys

Table A3: Variation in Travel (1989/91) by Car Ownership and Settlement Size

Settlement Size	Car Ownership				Overall
	0	1	2	>2	
London	+15%	-8%	-5%	-18%	-8%
Metropolitan	-5%	-15%	-17%	-4%	-23%
>250,000	-7%	-10%	-8%	-4%	-11%
100-250k	-8%	+3%	-12%	+1%	-3%
50-100k	+11%	+6%	-8%	-8%	-1%
25-50k	-1%	-3%	+1%	-12%	-2%
3-25k	-10%	+9%	+7%	+7%	+12%
Rural	+17%	+17%	+23%	+19%	+36%
Average (kilometres)	86.2	198.6	288.4	311.0	197.3

Note: Figures for 1989/91 in kilometres per person per week and variations around the average
Source: Based on Department of Transport (1995)

A4: Travel by Population Density and Settlement Size - % of total distance travelled by mode, diary day 7 – NTS 1998-2000

Persons per hectare	Car	Public Transport	Walking	Cars per household
Less than 1	0.92	0.06	0.02	1.42
1-15	0.89	0.09	0.02	1.31
15-40	0.84	0.13	0.03	1.14
Over 40	0.74	0.21	0.05	0.91
Settlement Size				
All Great Britain	85.32	11.79	2.89	1.18
London	66.10	29.13	4.77	1.01
Metropolitan areas	84.03	12.29	3.67	1.02
Other over 100K	84.69	12.13	3.18	1.10
3000 to 100,000	89.15	8.43	2.42	1.27
Under 3000 (Rural)	91.23	7.25	1.52	1.49

Source: Based on Dargay and Hanly (2004)