THE DETERMINANTS OF LONG DISTANCE TRAVEL: AN ANALYSIS BASED ON THE BRITISH NATIONAL TRAVEL SURVEY

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ABSTRACT

This study analyses of the determinants of long distance travel in Great Britain using data from the 1995-2006 National Travel Surveys (NTS). The main objective is to determine the effects of socio-economic, demographic and geographic factors on long distance travel. The estimated models express the distance travelled for long distance journeys as a function of income, gender, age, employment status, household characteristics, area of residence, size of municipality, type of residence and length of time living in the area. A time trend is also included to capture common changes in long distance travel over time not included in the explanatory variables. Separate models are estimated for total travel, travel by each of four modes (car, rail, coach and air), travel by five purposes (business, commuting, leisure, holiday and visiting friends and relatives (VFR)) and two journey lengths (<150 miles and 150+ miles one way), as well as the 35 mode-purpose-distance combinations.

The results show that long distance travel is strongly related to income: air is most income-elastic, followed by rail, car and finally coach. This is the case for most journey purposes and distance bands. Notable is the substantial difference in income elasticities for rail for business/commuting as opposed to holiday/leisure/VFR. In addition, the income elasticity for coach travel is very low, and zero for the majority of purpose-distance bands, suggesting coach travel to be an inferior mode in comparison to car, rail and air. Regarding journey distance, we find that longer distance journeys are more income elastic than shorter journeys.

For total long distance travel, the study indicates that women travel less than men, the elderly less than younger people, the employed and students more than others, those in 1-adult households more than those in larger households and those in households with children less than those without. Long distance travel is also lowest for individuals living in London and greatest for those in the South West, and increases as the size of the municipality declines.

Keywords: travel demand modelling, long distance travel, income elasticities

INTRODUCTION

The study presented in this paper is part of a larger project concerned with the prospects for longer distance travel in Great Britain (Dargay, 2010), which was carried out for the Independent Transport Commission. The motivation for the project was twofold. First, long distance travel makes up a substantial proportion of total travel mileage. Although trips of 50 miles or more one-way make up less than 2% of all journeys made by British residents in Great Britain, they account for about 1/3 of the distance travelled. In addition, both long distance travel and average trip length have increased over the past decades. It is thus apparent that long distance travel and how it develops in the future will have important implications for the environment and for congestion. The second motive is that existing knowledge of long distance travel in Britain is limited. A major aim of the project was to contribute to our understanding of this important travel segment.

The objective of the project was to produce projections for long distance travel by car, rail, coach and air in Great Britain to 2030. The projections are based on a forecasting model which incorporates the effects of economic and demographic factors, policy measures and developments in transport supply. Each of the four modes is broken down into five journey purposes: business, commuting, leisure day trips, visiting friends and relatives (VFR) and holiday. Since competition between modes is not the same for all distances, the demand for car, rail and coach is further divided into two distance bands: 50 to less than 150 miles, and 150 miles and greater, while air is only considered a relevant mode for trips of 150 miles or more.

Various data sources were used to obtain estimates of the parameters in the model. The influence of socio-economic and demographic factors on long distance travel is based on econometric models using the British National Travel Survey (NTS) for the years 1995 to 2006. This paper presents the results of this analysis.

The structure of the remainder of the paper is as follows. We begin with a discussion of the measurement of long distance travel, describing the methodologies used in various travel surveys and the problems encountered. A brief review of the literature on the determinants of long distance travel follows. The next section is a descriptive account of long distance travel in Great Britain based on the National Travel Survey. Thereafter follows the econometric analysis: the model specification, the estimation results and a commentary of the findings. A summary of the main determinants of long distance travel and policy implications conclude the paper.

MEASURING LONG DISTANCE TRAVEL

Longer distance journeys are relatively rare events and they therefore present special challenges when it comes to data collection. A paper by Axhausen (2001) provides a review of the methodologies used by various European nations to measure long distance travel during the 1990s. The review shows a great deal of variation in the methodologies and definitions. Some countries used simple postal surveys whilst others used more personal contacts such as telephone and household visits. Fundamentally, even the simple definition of what constituted a long distance journey varied, from between 50 to 100km, and the recall period over which respondents were asked to record such journeys varied from just 2 weeks to 3 months. A comparison of the statistics from the surveys in five European nations shows some consistencies (car as a mode for long distance travel is dominant) and some inconsistencies (the distribution of trips by distance bands). The paper then describes pilot experiments in five counties to design a common survey framework. Important factors considered when evaluating the pilots included the response rate; the number of journeys reported and the frequency of reporting of at least one longer distance journey. The paper makes a number of recommendations on how to best survey long distance journeys, primarily: take a person sample; make an initial telephone contact; follow up with face-to-face interviews; have a retrospective 8 week recall period and apply a 100km threshold. Madre and Maffre (2001) provide a more detailed description of the methodology used in the French National Passenger Survey to collect short, medium and long distance (over 80km) journeys within the same survey. This approach is shown to be in contrast to the approach in the United States that uses an additional survey to the Nationwide Personal Transportation Survey (NPTS) to capture longer distance journeys (the American Travel Survey, ATS) (Bricka 2001). The authors generally recommend using the same survey to collect all kinds of travel but suggest some safeguards to maintain data quality for both short and longer journeys.

On the important matter of memory recall of long distance journeys, a study that tries to assess the accuracy with which respondents are able to recall journeys made in the past is reported in Denstadli and Lian (1998). The data they used consisted of sporadic (not repeated) long distance (over 100km) trips reported over a previous three month period by respondents to the telephone based Norwegian National Travel Surveys in 1985 and 1992. From a tabulation study, if the reporting of trips during the first month previous was taken to be the correct level of trip making then the average under reporting in months two and three was substantial at 31%. This level of under reporting was not seen to vary much by purpose; distance; mode or individual mobility. However, longer distance trips were better recalled and amusement trips (e.g. to the theatre or an amusement park) had poorer recall. The paper concludes that some pre-contact before the survey may help with recall, allowing the respondent to better consider their history of longer distance journeys and that a shorter, one month, recall period would help with data quality.

Another strategy to overcome this underreporting is to develop a methodology that can infer longer distance trip making from knowledge about the most recent long distance journey that the respondent has made. This is the topic of a paper by Richardson and Seethaler (2001). In their paper they present a probabilistic model for an average trip rate multiplier, as a function of the number of days since the long distance trip was made. This model is tested with monte carlo simulations in an EXCEL model. To begin with a simulation model was developed using the conventional recall technique to compare with the most recent trip technique. Critically this conventional model did not assume memory lapses on the part of the respondent. For a 30 day recall period, the most recent trip technique was shown to produce average and variability in trip rates close to those from the recall technique, which itself assumed prefect recall of trip making.

From this review it can be seen that there are issues around how long distance journeys are recorded and the quality of the data collected may vary according to the methodology used in the survey. This will also be relevant for any analysis carried out using such data and for interpretation of the results obtained.

EVIDENCE ON FROM PREVIOUS STUDIES

There have been relatively few studies concentrating mainly on long distance travel, and some of these papers have presented evidence based on cross tabulations of important factors whilst others have been based on econometric models. Some of the more relevant are discussed in the following.

Orfeuil and Soleyret (2002) compare the characteristics of weekday and weekend short distance journeys and long distance journeys reported as part of a 1994 French National Transport Survey. The journeys were measured as the average distance travelled per week and long distance journeys of 100km or more were taken from a recall of those made within the past 3 months by an individual within the household. The explanatory variables were: position in life cycle (age and family size); social position (income) and degree of urbanisation (conurbation size and proximity to urban centre). Using univariate and cross tabulations, greater longer distance travel was seen to be made by mid age groups and by people with higher incomes. The amount of long-distance travel is also greater for those living in central areas and, in percentage terms, this travel is less dominated by the car.

Two complementary studies into the European long distance market are by Limtanakool (2006a and 2006b). The first paper (2006a) uses National Travel Survey type data from the UK and the Netherlands to predict whether an individual is likely to make a longer distance journey of a particular type using a particular mode (commuting; business and leisure, each by train or private vehicle). For both datasets the threshold for a long distance journey was taken to be 50 km. The models are estimated as a series of binary logit models using socio demographic data (on gender; age; income and household composition; car availability); calendar data (in effect, day type) and some measure of the urban pattern (primarily through population density). Within each of the twelve models reported in this paper not all the explanatory variables were consistently present in all models. Being female was generally seen to reduce the probability of making a long distance journey whilst having a high income was seen to increase the probability. More complex household structures decreased the probability of making longer distance business or leisure trips and living in a more densely populated area (particularly in the UK) was seen to also reduce the probability of making long distance journeys. The overall conclusion was that the socio demographic characteristics of the individual and their household were the most important determinants.

The companion paper (2006b) uses the same Dutch National Travel Survey data to move beyond the prediction of trip making behaviour and predict the binary mode choice (between car and train) of Dutch travellers for commuting, business and leisure purposes. Once again socio demographic variables are included as candidate explanatory variables, but these are supplemented with measures of land use at both the origin and destination (as specialisation and diversity of land use) and (for an additional, expanded, model) journey time (measured as a ratio and a difference of rail verses car journey time). Being female and in particular, being female in employment increases the probability of choosing train. Also, the more dense the urban area at the destination, the more likely that the train mode is used for longer distance trips. The presence of journey time variables in the expanded model was shown to improve the goodness of fit over the base model and the behaviour of the parameters estimated were intuitive.

Two companion papers that explore the long distance travel behaviour of segments of the population are by Georggi and Pendyala (2001) and Mallett (2001). Both papers use long distance travel data of 100 miles or more from the 1995 American Travel Survey (ATS), with an analysis of the data using cross tabulations, whilst the Georggi and Pendyala paper additionally attempted regression models to explain trip volumes. Mallet found that people in the highest income households made 4 times as many trips annually as those in the lowest income group, with the smaller average for the low income people resulting from many people who made no long distance journeys at all (between 60% and 80% did not make any reported trips during the year). The most “immobile” group were seen to be African Americans, Hispanics and those in households without a vehicle. For low income households, long distance trip making was greatest amongst young adults whilst for higher income groups it was greatest amongst the late middle aged. Business and leisure trips were most numerous for people from higher income households whilst in lower incomes visiting friends and relatives and personal business were the most common purpose. Car was the dominant mode of travel for all income groups but low income households were more car dependant.

The paper by Georggi and Pendyala (2001) looks at two distinct groupings, one by four age bands and another by four income (per person) measures. In addition to cross tabulations of the ATS for each of these groups (akin to the work by Mallet, 2001) they present regression equations which attempt to explain trip rates for each sub group using dummy variables representing income, age, household structure, ethnicity, education, employment and car availability. The results show that higher levels of car ownership, income and a post graduate education increase the number of long distance trips, whilst African Americans, Hispanics and single people with children tend to make fewer trips. The R^2 values from these models tend to be on the low side, at most 11% and typically 4%.

Mokhtarian et al (2001) also present regression models to explain long distance travel demand, measured as the travel distances reported by individuals living in San Francisco provided in a be-spoke survey. The contention of the paper is that some individuals actually perceive a positive utility in travel (i.e. they enjoy the journey) and that the inclusion of terms that reflect this positive utility will enhance the quality of the model. Models were estimated for total long distance travel (over 100 miles) as well as travel for work/school or entertainment and by personal vehicle or airplane. The R^2_{adj} statistics from these models at 10% to 30% were higher than those found in the study by Georggi and Pendyala but this could be explained by the smaller sample used here. Of the traditional demographic factors, income and car availability were seen to be positively related to travel distance, whilst living in larger households or being female was seen to reduce long distance travel. Variables that captured objective mobility (e.g. frequency of trips by various purposes) were seen to have a positive relationship, as was the excess travel variable (a measure of the tendency to make an “unnecessary” journey). A negative effect on distance was seen from those people who identified travel stress, frustration and negative commuting attributes as important. The paper concludes that the amount of travel that an individual undertakes is not just determined solely by demographic factors but is also influenced by their attitudes, personality and lifestyle and that some combination of these factors may make an individual positively value travel distance and time thereby adding travel distance.

As we have seen, some studies have used cross tabulations to examine the impact of various factors on long distance travel whilst a few have used some form of regression analysis. The clearest and consistent conclusion to emerge from these studies is that income is an important factor in determining the quantity of long distance travel (either as an event, a number of trips or a distance). Individuals with higher incomes make more long distance travel and this is true irrespective of purpose or mode of travel. Also, females undertake less long distance travel (and this is most pronounced for commuting and business purposes) and a large or complex family structure also reduces most kinds of long distance travel, particularly by non-car based modes.

LONG DISTANCE TRAVEL IN GREAT BRITAIN

The National Travel Survey

There is no specific survey for long distance travel in Great Britain. The National Travel Survey (NTS) does however provide information on all travel in GB by British residents, including long distance trips. The NTS is based on a sample of private households in Great Britain, using a stratified multi-stage random probability approach. Individuals in sampled households are interviewed face-to-face to obtain information about the household, the individuals in the household, household vehicles and all journeys recently made by household members. Each member of the household is asked to complete a seven-day travel diary, with adults reporting for younger children and others unable to provide information on their own behalf. Within six days of the end of the travel week the interviewer returns to collect the travel records and to check the information recorded with the respondents.

In the travel diary, the individuals provide details of trips undertaken, including purpose, method of travel, time of day and trip length. A trip is defined as a one way course of travel having a single main purpose and can be composed of stages by different modes. In this paper, we use the terms trip and journey interchangeably, each being defined as “one way”. Short walks (less than one mile) are only recorded on the seventh diary day. Information on long distance journeys, defined as trips of 50 miles of more (one way), is collected for a four week period (two weeks from 2006) – during the one week diary period and retrospectively in the initial interview for the previous three weeks (one week from 2006).

The NTS includes a number of weights which are intended to improve the accuracy and representativeness of the data. Household weights adjust for non-response bias. Journey weights adjust for the drop-off in the number of trips recorded by respondents during the course of the travel week and long distance journeys weights adjust for drop-off in the number of long distance journeys reported over the reporting period and for under-reporting of journeys reported retrospectively in comparison with those reported during the diary week.

Initially, our intention was to use both the diary and retrospective data for the analysis of long distance travel. However, a significant reduction in long distance travel between 2005 and 2006 was noted which was likely to be explained by the reduction in the length of the retrospective travel period in the 2006 survey (from three weeks to one week. As noted in the second section of this paper, the retrospective data tends to over-represent longer distance long distance journeys. By reducing the length of the retrospective period in 2006, this over-representation of longer trips is reduced in comparison to earlier years, thus resulting in an apparent fall in long distance travel in 2006. For this reason it was decided to base the analysis solely on the long distance travel reported in the week long travel diaries.

Long distance travel is defined as journeys or trips of 50 miles or more one-way in the NTS, and we also choose to use this definition. As with all journeys in the NTS, long distance journeys are comprised of stages by different modes. For example, a 100 mile journey (trip) may include a 10 mile car drive from home to a rail station, 85 miles by rail and a 5 mile taxi ride from the destination rail station to the final destination. Although each of these three stages is reported separately in the NTS, journeys (trips) are defined in terms of the main mode used, so the journey described is considered as a 100 mile, one-way journey or trip by rail. We also use the “main-mode” definition.

This study is based on the NTS data for the survey years 1995 to 2006. Before 1995, weights are not available so the data cannot be made comparable to the later years.

The remainder of this section describes long distance travel in Great Britain by mode, journey purpose and distance. The figures are based on the NTS diary sample data for the years 2002-2006.

Travel by mode

Table 1 shows average annual[1] long distance travel per person for the years 2002-2006 in miles, numbers of trips and average trip length by mode and totally[2]. During this period each individual in Britain made on average 20.5 long distance journeys per year, travelling 2114 miles. The average trip length was 103 miles (one way). As expected, the average trip length was shortest by car and longest by air. We also note that trip length is slightly longer by coach than by rail.

The dominance of the car for long distance travel is apparent from the table. Car accounts for on average 77% of the total distance travelled, followed by rail (11%), coach (6%) and finally air (4%), with other modes accounting for the remainder[3]. In terms of trips there are some notable differences. Air accounts for a much smaller proportion of long distance trips than it does of distance travelled reflecting its high trip length, while the opposite is the case for car.

Table 1: Average annual long distance travel per capita, mean 2002-2006 NTS

	Car	Rail	Coach	Air	Total
Total distance (miles)	1654	252	132	75	2114
Trips	16.9	2.3	1.1	0.2	20.5
Average trip length, miles	98	110	122	406	103
% of total long distance miles	77%	11%	6%	4%	
% of all long distance trips	82%	11%	5%	1%	

Comparison of travel diary information on long distance journeys with journeys of all distances for the years 2002-2006 indicates that although long distance journeys account for only about 2% of trips, they make up about 31% of all miles travelled. By mode, long distance journeys account for 29% of car miles, 68% of coach miles, 54% of rail miles and 100% of air miles. In terms of all trips, the figures are 3% for car, 15% each for both rail and coach and 100% for air. Coach, rail and air are clearly predominantly long distance modes, whereas car is mainly used for shorter distance trips.

Travel by journey purpose

The breakdown of long distance travel by purpose is shown in Table 2. Of total distance by all modes (final column), visiting friends and relatives (VFR) accounts for the greatest share (28%) and commuting for the smallest (10%), while leisure and holiday make up 21% each and business, 20%. Regarding the individual modes, long distance mileage by car shows a

[1] Calculated assuming 52.14 weeks per year

[2] In this table and in all the analysis in this paper, we omit travel by modes other than the 4 modes (which accounts for only around 1.5% of distance travelled) and travel for purposes not easily categorized into the 5 purposes (which accounts for 4% of distance travelled).

[3] This can be compared with the mode shares of total miles travelled for both long and short distance trips: car (81%), rail (6%), coach (3%), air (1%), with other modes (including walk) making up about 8%.

similar pattern, which is not surprising given its large share of total long distance mileage. VFR also dominates rail travel (28%), with other purposes each accounting for between 16% and 22%. Coach is predominantly used for holiday (42%) and leisure (38%) travel, and seldom for commuting (3%) and business (5%), while air is mainly used for business (55%) and holiday (25%).

Table 2: Long distance travel, journey purpose shares (%) of distance travelled by mode, 2002-2006 NTS

	Car	Rail	Coach	Air	Total
Business	20	22	5	55	20
Commuting	9	18	3	3	10
Holiday	21	16	42	25	21
Leisure	21	16	38	6	21
VFR	30	28	12	11	28

Shares do not sum to 100 due to rounding.

The mode shares for the different journey purposes are shown in Table 3. Car is the dominant mode for long distance travel for all purposes: for the 2002-2006 period, it accounted for on average from 75% of business and holiday mileage to 84% of VFR. The share of rail is greatest for commuting (23%) and lowest for leisure and holiday travel (9% each), while coach's share is greatest for leisure and holiday (12% and 11%) and smallest for business and commuting (2% each). Air's share is greatest for business travel (10% of distance) and holiday (4%).

Table 3: Long distance travel, mode shares (%) of distance travelled by journey purpose, 2002-2006 NTS

	Car	Rail	Coach	Air
Business	75	13	2	10
Commuting	74	23	2	1
Holiday	75	9	12	4
Leisure	79	9	11	1
VFR	84	12	3	1

Shares do not sum to 100 due to rounding.

Travel by distance band

Table 4 shows long distance travel by trip distance: less than 150 miles and 150 miles or more. The greater part of total travel for trips over 50 miles (63%) is for trips under 150 miles one way (last column). Clearly, miles travelled by the different modes also have different distributions by distance band. Only a third of long distance car mileage is for trips 150 miles or more, while essentially all air travel falls in this distance band. Rail and coach travel are split more evenly between the two bands, with coach travel having a nearly equal distribution.

Table 4: Long distance travel, distance band shares (%) of distance travelled by mode, 2002-2006 NTS

	Car	Rail	Coach	Air	Total
< 150 miles	68	57	51	0	63
150+ miles	32	43	49	100	37

The mode shares also differ by journey distance. As shown in Table 5, although car dominates both distance bands, its share is far higher for trips less than 150 miles than it is for trips over 150 miles. For longer long distance trips, the shares for all other modes are higher than for shorter long distance trips.

For journeys between 50 and 149 miles, car accounts for 84% of mileage, rail for 11% and coach for 5%, while for journeys over 150 miles, the comparable shares are 68%, 14% and 8%, with air accounting for 10%.

Table 5: Long distance travel, mode shares (%) of distance travelled by distance band, 2002-2006 NTS

	Car	Rail	Coach	Air
< 150 miles	84	11	5	0
150+ miles	68	14	8	10

ECONOMETRIC ANALYSIS

Model Specification

Our analysis is concerned with the total amount of long distance travel an individual undertakes during a given period. Travel is generally measured in terms of distance or trips, and both of these measures available in the NTS. However, since trip length can vary considerably and can change over time, we feel that distance travelled is a better indicator of long distance travel. Thus, the estimated models express the total distance travelled, in miles, for long distance journeys by individual *i*, D_i , in terms of *K* socio-economic, demographic and geographic characteristics, X_{ki}, and a time trend, *t*:

$$D_i = \alpha + \sum_{k=1}^{K} \beta_k X_{ki} + \gamma t + \varepsilon_i$$

where α is a constant intercept term, β_k are the coefficients of the *K* factors, γ is the parameter relating to the time trend and ε_i is a random error term. The time trend is included in the model since we are combining NTS data for a number of years and it allows for any changes in travel over time which are unrelated to the other explanatory variables included in the model.

The independent (X) variables are defined as characteristics that can be thought to influence long distance travel. These include the attributes of the individual: age, gender, employment status; of their households: household composition and household income; and of their residences: housing type and the length of time resident. Variables relating to residential location are also included as these may also impact on travel demand: size of the municipality in terms population and region in which the household resides.

Long distance travel is also clearly related to car ownership. A structural model is comprised of two equations: the first equation determining the household's car ownership and the second relating to the individual's travel, given the household's car ownership. By estimating the structural model, we can distinguish between direct effects of the explanatory variables on the individual's travel and the indirect effects on travel via the influence of these variables on household car ownership decisions. Alternatively, our approach is to estimate a reduced-form equation for travel, which is obtained by substituting car ownership in the travel equation by its determining factors, which are the same as those which determine overall travel decisions. The coefficients of the variables in the reduced form model include both the direct effects of the explanatory variables on travel demand and the indirect effects via their effects on car ownership. This method also avoids the problem of the possible endogeneity of car ownership in the travel equation. However, we do take access to a company car into account, by including this as a separate variable since this is a specialised form of car ownership, which is not necessarily related to income.

ESTIMATION RESULTS

The models were estimated at the individual level for all respondents completing the travel diary in the 1995 to 2006 National Travel Surveys. For the 12 years this gives a sample of 147,826 individuals. The journeys are weighted to adjust for drop-off in the number of journeys reported over the reporting period. Because of the problems with the retrospective data on long distance journeys discussed earlier, only long distance journeys reported during the diary week are used for the analysis. The dependent variable is thus distance travelled for journeys of 50 or more miles, one way, over a weekly period.

A total of 47 models was estimated: total travel, travel by each of four modes (car, rail, coach and air), travel by five purposes (business, commuting, leisure, holiday and VFR) and two journey lengths (<150 miles and 150+ miles one way), as well as 35 mode-purpose-distance combinations[4]. The daily diary data were weighted to adjust for the drop-off in the number of journeys reported over the travel week. The models were estimated by weighted least squares using the diary sample household weights provided by the NTS to correct for non-response bias. In all cases, the estimated coefficients of the majority of the variables are highly significant and of the expected signs. The goodness of fit is typical of models estimated on the basis of individual repeated cross-section data (with adjusted R^2 between 0.10 and 0.20, as also reported by Georggi and Pendyala, 2001).

[4] No model for air is estimated for journeys less than 150 miles as these are very marginal.

The estimated coefficients, standard errors and t-statistics for the model for all long distance travel by all modes are shown in Table 6. With the exception of income and the time trend, the variables included in the models are categorical so that the coefficients are interpreted in relation to an excluded, or base, category: male, age 60+, unemployed/retired/home maker, main driver of company car, 5-10 years residence at current address, South East, metropolitan area, two adult household, children in household, semi-detached house[5]. The reference categories are shown in bold and the different characteristic groups are separated by the banding. Variables which are not statistically significant at the 0.10 level are omitted from the estimation (no estimates reported) so that omitted variables in each group are not statistically different from the reference category.

As expected, the income variable is highly significant: long distance travel increases with income. The implied income elasticity[6] is 0.51 calculated at mean distance and income. The time trend is not significant, so there is no trend over time not explained by the other explanatory variables included in the model.
Further, we see that long distance travel is lower for women than for men, greater for those under 60 than for those over 60, greater for the employed and students than for the unemployed/retired/home makers and considerably lower for those who do not have company cars than it is for those who do.

Length of residence at current address is also shown to have a significant effect on travel, with long distance travel generally declining the longer an individual lives at the same address. Regarding regional variations, individuals living in the excluded regions – West Midlands, South East, Eastern England and Scotland – are not significantly different from each other in terms of distance travelled, while those in the South West and East Midlands (positive coefficients) travel more and those in the North East, North West, London and Wales (negative coefficients) travel less. Clearly, Londoners travel least in terms of distance, whilst those in the South West travel farthest. Long-distance travel also increases as the size of the conurbation in terms of population decreases, and is, as expected, greatest for those living in rural areas.

Regarding household composition, long distance travel is greater for individuals in one adult households than it is for those in two adult households and it is lowest for those in households with three or more adults. Travel is also lower for those living in households with children, than for those in households without. Finally, long distance travel is greater for individuals living in detached houses, even once income and conurbation size are controlled for.

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[5] Choice of reference category is immaterial because the coefficients can be transformed to any other reference category.

[6] Given the linear function used, the elasticities are not constant but are dependent on distance and the level of income. Those reported in this paper are calculated at the mean values of these variables, so the income elasticity is $= \beta\overline{Y} / \overline{D}$ where β is the coefficient of income (Y) and D is distance travelled.

The results regarding the impacts of socio-economic, demographic and geographic variables on long distance travel are generally in agreement with those found for all travel in other studies (Giuliano and Dargay, 2006). This is perhaps not surprising as long distance travel makes up about a third of total distance travelled.

Table 6: Estimated model for distance travelled by all modes for trips 50 miles or more, 1995-2006 NTS

	Coefficient	Std. Error	t-value
Household Income	0.0013	0.00	38.8
Survey year			
Male			
Female	-12.07	0.61	-19.7
Age <60	1.91	1.03	1.9
Age 60+			
Unemployed/retired/home			
Employed	16.79	0.75	22.4
Student	14.63	1.81	8.1
Main driver of company car			
Not main driver of company car	-127.86	1.94	-66.0
Residence < 1 year	10.50	1.33	7.9
Residence 1-2 years	4.21	1.26	3.3
Residence 2-3 years	3.39	1.29	2.6
Residence 3-5 years	2.08	1.10	1.9
Residence 5-10 years			
Residence 10+ years	-3.29	0.90	-3.7
Residence always	-6.34	1.04	-6.1
North East	-3.04	1.51	-2.0
North West	-2.18	1.00	-2.2
East Midlands	2.76	1.20	2.3
West Midlands			
Eastern England			
London	-8.99	1.08	-8.3
South East			
South West	8.52	1.13	7.5
Wales	-4.38	1.42	-3.1
Scotland			
Metropolitan area			
Population over 250K			
Population 25K-250K	1.87	0.81	2.3
Population 3K-25K	5.58	0.92	6.1
Rural	8.68	1.13	7.7
Adults 1	7.77	0.91	8.5
Adults 2			
Adults 3+	-11.13	0.78	-14.3
Children none	11.50	0.77	15.0
Children 1+			
House Detached	11.40	0.84	13.6
House Semi-detached			
House Terraced	-1.93	0.76	-2.5
House - Flat	-7.73	1.15	-6.7
Accommodation other			
Constant	133.34	2.41	55.3

The impact of income on long distance travel

Because of the large number of models estimated, in order to conserve space, only the main results for the different categories of long distance travel are summarised in this paper.[7] Of greatest interest are the income elasticities. These are shown in Table 7, calculated at the mean travel distance and income for each travel category.

The middle section of the table shows the elasticities for each mode-purpose-distance band combination separately. The row in bold are the elasticities by mode for all purposes, whilst the column in bold are the elasticities by purpose for all modes.

Regarding the elasticities for the individual modes, air is most income-elastic (1.44), followed by rail (0.83), car (0.46) and finally coach (0.10). The income elasticity for air above unity reflects its luxury nature, whilst the low income elasticity for coach suggests it is considered an inferior mode in comparison to car, rail and air. The rank order of the elasticities by mode is the same for most journey purposes and distance bands. The most marked exception is VFR for which car is more income elastic than rail. For coach travel, income is only a significant factor for longer distance leisure and VFR trips.

The income elasticity for all modes together is similar for the different journeys purposes, with the exception of leisure which is much less income elastic. Notable is the substantial difference in income elasticities for rail for business/commuting as opposed to holiday/leisure/VFR.

Table 7: Income elasticities for long distance travel estimated from the NTS and real average household income (1995 – 2006) in 2000 prices

Purpose	Distance (miles)	Car	Rail	Coach	Air	All modes	Household income (thousand 2000£)
Business	<150	0.34	1.39	0.00	*	**0.57**	24.2
	150+	0.54	1.51	0.00	1.53		
Commuting	<150	0.31	1.34	0.00	*	**0.57**	23.7
	150+	0.50	1.57	0.00	*		
Holiday	<150	0.38	0.64	0.00	*	**0.50**	19.1
	150+	0.61	0.56	0.00	1.31		
Leisure	<150	0.31	0.50	0.00	*	**0.33**	19.0
	150+	0.47	0.43	0.28	1.26		
VFR	<150	0.53	0.25	0.00	*	**0.56**	19.6
	150+	0.70	0.42	0.31	1.63		
All purposes	<150	-	-	-	-	0.42	20.7
	150+	-	-	-	-	0.67	
	All	**0.46**	**0.83**	**0.10**	**1.44**	**0.51**	
Household income (thousand 2000£)		20.8	21.7	14.9	25.9	20.7	

* air travel under 150 miles and air commuting are not estimated as there are too few observations- not estimated

[7] The full econometric results are reported in the appendix of Dargay (2010).

Regarding journey distance, we find that longer distance journeys are generally more income elastic than shorter journeys. This is true for all modes and purposes together (0.67 versus 0.42) and for most mode-purpose combinations. Interestingly the total elasticities differ little by journey purpose, with only leisure being less income-elastic than the other purposes.

Also shown in the table are the mean incomes for individuals making each type of long distance trip, weighted by their travel distances. As expected, coach users have the lowest incomes and air travellers the highest; they differ by a factor of 1.7. Car and rail users have similar incomes, with those of rail travellers being slightly higher. Regarding journey purpose, business and commuting travellers have higher incomes than the average for other purposes. It can also be mentioned, that with regards to journey distance (not shown in the table), incomes are slightly higher for longer distance trips than for shorter distance trips (for all modes and purposes together 21.1 compared to 20.4).

Since the elasticities are estimated from repeated cross-section data, only static models could be used, so that the interpretation of the elasticities as short- or long-run is not clear cut. Empirical evidence suggests that such elasticities fall between the short- and long-run values, so we interpret these as medium-run elasticities (Goodwin et al, 2004). This is supported by comparison with elasticities obtained from time-series analysis (Dargay, 2010): the income elasticities for all long distance travel by each mode are generally between the short- and long-run values obtained from dynamic models.

The sensitivity of the elasticity estimates to the time period used in the estimation was also examined. This was done by estimating the model for the two periods separately (1995 to 2001 and 2002 to 2006). The resulting income elasticities are shown in Table 8 and compared with those estimated on the basis of the full 1995 to 2006 sample. The elasticities are presented for each mode, purpose and distance band rather than for all combinations of these as in the previous table. Firstly, it can be noted that the elasticities estimated for the whole sample (1995 to 2006) are in between the elasticities for the two sub-periods in all cases. This is as would be expected.

Table 8: Income elasticities estimated for different sample periods, NTS

		Sample period		
		1995 to 2001	2002 to 2006	1995 to 2006
Mode	Car	0.36	**0.49**	0.46
	Rail	**1.04**	0.74	0.83
	Coach	0.00	**0.15**	0.10
	Air	**1.76**	1.38	1.44
Purpose	Business	0.56	**0.63**	0.62
	Commuting	0.45	**0.64**	0.57
	Holiday	0.44	**0.51**	0.50
	Leisure	0.28	**0.36**	0.33
	VFR	0.55	**0.58**	0.56
Distance	<150 miles	0.34	**0.45**	0.42
	150 + miles	0.66	**0.67**	0.67

The greater of the elasticities for the two sub-samples is shown in bold. Regarding mode, the elasticities for car and coach are higher for the most recent period, while the opposite is the case for rail and air. This is contrary to what one would expect given the evidence that growth in car and coach is slowing down, whereas growth in rail and air travel is continuing at relatively high rates. Considering journey purpose and distance, in all cases the elasticities for the latter period are greater than for the earlier period.

Although these estimates generally suggest that the elasticities are increasing over time, we must be cautious in this interpretation. Given that the number of individuals in each year is far greater than the number of years in the data sample, the elasticities will largely reflect differences in travel and income between individuals rather than differences over time. It is well-documented (Penyala et al, 1994) that elasticities based on cross-section data show a good deal of variability over time which generally cannot be explained. This questions the existence of a unique equilibrium which is implicitly assumed in cross-section models, or at least the possibility of estimating it on the basis of cross-section data. It is thus preferable to base elasticity estimation on dynamic models, or if this cannot be done (as is the case with the repeated cross-section data in the NTS), to use as many cross-sections as possible.

The impact of demographics on long distance travel

Estimates of the impacts of demographic factors on long distance travel are shown in Table 9. For ease of exposition, these are presented for total travel and for each mode, purpose and distance band rather than for all combinations of these. Zero cells denote that the estimated value is not statistically different from zero.

The values shown in the table are the estimated coefficients in relation to the estimated mean distance travelled in each travel category. This permits comparison across the different travel categories, which vary considerably in distance travelled. The sign indicates whether individuals with the given attribute travel more (+) or less (-) than individuals in the reference category (see Table 6).

It is apparent that women travel less than men in the majority of travel categories. The only exceptions are coach, holiday and VFR, where there is no significant difference between the genders. The most substantial differences between men and women are for commuting and business trips and for air travel. Recall that these differences are after controlling for employment, so that the large negative value for commuting reflects shorter commuting distances by working women. Working women also travel less for business, which also explains their lower air travel as business trips are a large proportion of air travel.

The over 60's travel more by coach and less by car than those under 60, and less for leisure and VFR but more for holiday. It must be held in mind that the travel considered here is only within GB and the affect of age could be different if international travel were also included.

Regarding employment status, the employed and students travel more in totally, and by most modes and for most purposes, than do other individuals. Students travel greater distances by rail and coach and for leisure and VFR than the employed, but less by car and air. Employment status has no impact on holiday travel, at least within GB. As expected, the employed account for all business and commuting travel.

As noted earlier, long distance travel increases as the size of the municipality of residence in terms of population decreases. In the table, we only show the effects of living in rural areas in relation to the reference category of metropolitan areas. This is the largest effect – areas in between generally either have smaller impacts or are not significantly different from metropolitan areas. The estimates show that those in rural areas travel longer distances than others. However, we see that this only relates to car travel, whilst living in a rural area has no impact on travel by the other modes. Regarding journey purpose, only holiday travel is not greater for those living in rural areas.

The final column shows the sign of the coefficient of the time trend. In only 3 instances is the time trend significant: rail travel has increased over the sample period, as has holiday travel, while commuting has declined. In all other cases, any changes over time are explained by the explanatory variables included in the model.

Table 9: Impact of demographic factors on long distance travel estimated from the NTS 1995-2006 (zero cells denote not significantly different from reference category)

	Woman	Age 60+	Student	Employed	1 Adult	3+ Adults	Children	Rural	Time
All travel	-0.30	-0.05	0.36	0.41	0.19	-0.27	-0.28	0.21	
<150 miles	-0.33	-0.05	0.33	0.43	0.14	-0.23	-0.28	0.25	
150 miles +	-0.24	0.00	0.42	0.39	0.28	-0.36	-0.28	0.13	
Car	-0.32	-0.10	0.13	0.41	0.10	-0.28	-0.22	0.26	
Rail	-0.22	0.00	1.68	0.62	0.58	-0.15	-0.66	0.00	+
Coach	0.00	0.59	0.82	-0.12	0.39	0.00	-0.23	0.00	
Air	-0.46	0.00	0.00	0.69	0.61	-1.00	-0.23	0.00	
Business	-0.86	0.00	0.00	1.08	0.37	-0.38	-0.15	0.19	
Commuting	-1.03	0.00	0.00	1.34	0.26	-0.21	0.00	0.50	-
Holiday	0.00	0.11	0.00	0.00	0.00	-0.36	-0.22	0.00	+
Leisure	-0.17	-0.16	0.29	0.19	0.00	-0.16	-0.36	0.32	
VFR	0.00	-0.18	0.64	0.07	0.28	-0.35	-0.53	0.22	

Household composition also has clear implications for long distance travel. Compared with individuals in households with 2 adults, those in 1-adult households travel more and those in households with 3 or more adults travel less. This is also the case for both distance bands and most modes and purposes. Notably, those in single adult households do not travel more for holiday and leisure than those in 2-adult households. However, they do travel further for business and commuting, suggesting that such travel decisions can be dependent on family circumstances. Interestingly, the impact of living in a single adult household is smallest on car travel, which presumably reflects the higher costs of using a car as a sole occupant. Living in a household with children under 16 also reduces long distance travel, but since the under 16s are included as separate individuals, this also reflects the lower long distance travel of this age group.

The impact of region on long distance travel

Regional variations in long distance travel are shown in Table 10. These are in relation to the reference region, so that a positive (negative) sign indicates that travel is greater (less) than in South East. The values are the estimated coefficients in relation to the mean travel distances for each travel category, so that the impacts can be easily compared.

From the first row, we see that Londoners travel least and those in the South West travel most. This is in agreement with figures for total travel based on the NTS. Distance travelled is also smaller in the North East, North West and Wales and greater in the East Midlands than in the remaining regions.

Considered by distance band, a different pattern arises. Individuals in most regions travel fewer miles for trips below 150 miles and more miles for trips 150 miles or more than individuals in the South East. In many regions these differences cancel out, resulting in only small or insignificant differences in travel between these regions and the South East. On the other hand, the lower total long distance travel noted for London in comparison to the South East is explained solely by less travel for trips less than 150 miles.

There are also notable regional variations in travel by mode. Londoners travel least by car and those in the South West most, as was the case for total travel. There is a lower tendency to use rail in the West Midlands and Wales than in the other regions, while coach is favoured in Yorkshire and the South West. The Scottish are most likely to travel by air, followed by those in the North East and London. This regional variation likely reflects differences in the supply and convenience of the alternative modes.

Table 10: Regional differences in long distance travel estimated from the NTS 1995-2006 (zero cells denote not significantly different from reference category: South East)

	North East	North West	York-shire	East Midlands	West Midlands	East	London	South West	Wales	Scot-land
All travel	-0.07	-0.05	0.00	0.07	0.00	0.00	-0.22	0.21	-0.11	0.00
<150 miles	-0.43	-0.29	-0.19	0.05	-0.13	0.00	-0.38	0.07	-0.33	-0.40
150 miles +	0.53	0.34	0.41	0.00	0.24	0.00	0.00	0.43	0.26	0.61
Car	-0.12	0.00	0.05	0.09	0.09	0.00	-0.23	0.24	-0.09	-0.16
Rail	0.00	-0.31	-0.18	0.00	-0.55	0.00	-0.31	0.00	-0.58	-0.29
Coach	0.31	0.20	0.51	0.35	0.27	0.00	-0.23	0.55	0.51	0.00
Air	0.69	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	4.67
Business	0.00	0.00	0.00	0.16	0.00	0.00	-0.29	0.23	0.00	0.25
Commuting	-0.37	-0.42	-0.48	0.00	0.00	0.00	-0.61	0.00	-0.85	-0.69
Holiday	0.16	0.19	0.27	0.38	0.16	0.00	0.00	0.28	0.17	0.38
Leisure	0.00	0.00	0.14	0.00	0.12	0.00	-0.16	0.41	0.00	0.00
VFR	-0.28	-0.29	-0.12	-0.20	-0.20	-0.09	-0.27	0.00	-0.35	-0.37

Travel by journey purpose also shows some regional variation. Londoners travel the fewest miles for business, whilst the Scottish travel the most. This is presumably explained by

London's predominance as a business centre. Both of these regions also show comparatively less long distance commuting mileage, but Wales has even less. Holiday travel is greatest for the Scottish, while those in the South East, East and London travel least for this purpose. Leisure mileage is greatest for those living in the South West and lowest for Londoners, whilst those in the South East and South West travel most for VFR and those in Scotland and Wales least.

CONCLUSIONS

The main objective of this paper has been to examine the determinants of long distance travel in Great Britain. This was done on the basis of econometric models estimated using data from the National Travel Survey. Separate models were estimated for four modes (car, rail, coach and air), five journey purposes (business, commuting, holiday, leisure and visiting friends and relatives) and two distance bands (less than 150 and 150 miles or more one way). The main conclusions are summarised below.

As expected, income is a major determinant of long distance travel. The aggregate income elasticity (all modes, purposes and distance bands) is about 0.5, which we interpret as medium-run. However, the range is very wide, from 0.0 to 1.6, depending on mode, purpose and distance band. Regarding the modes, we find that air is most income-elastic, followed by rail, car and finally coach. This is the case for most journey purposes and distance bands. Air travel is the only mode with an overall income elasticity in excess of unity, suggesting it to be a luxury mode, based on the normal economic definition. Regarding journey purpose, most notable is that the income elasticities for rail for business and commuting are also greater than 1.0 and thrice as high as for holiday, leisure and VFR. In addition, longer distance journeys have higher income elasticities than shorter distance journeys.

On the basis of these income elasticities, the modal shares of air and rail will increase in comparison to car and coach as incomes rise. Road congestion resulting from long distance journeys will increase less than proportionally to income, as will the environmental problems associated with car travel. On the other hand, the high income elasticities for air travel imply large increases in air travel and its environmental consequences. The overall effects on the environment will depend, of course, on developments in technology.

The elasticities also indicate that long distance trips will become longer as income rises.

Other factors shown to be important for long distance travel are gender, age, employment status and household composition. Women travel less than men, the over-60s less than younger people and the employed and students more than those not employed. Household size is also important, with individuals in 1-adult households travelling more than those in 2-adult households and those in households with 3 or more adults travelling less. Those in households with children also travel fewer miles for long distance trips than those without children. These finding are relevant for future long distance travel demand, since the proportions of women, the over-60s and single-person households are expected to increase over the coming decades.

There are also geographic and regional differences in long distance travel. As might be expected, those living in rural areas travel longer distances than those living in more built-up areas. There are also clear regional differences: long distance travel by all modes and by car is lowest in London and greatest in the South West, while travel by air is greatest for those living in Scotland. The regional variation partially reflects differences in the supply and convenience of alternative modes. The increase in regional airports serving domestic destinations, the introduction of high-speed rail and the rise in motorway congestion will have implications for regional variations in long distance travel.

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