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SEGMENTATION OF THE TRAVEL MARKET IN LONDON: ESTIMATES OF ELASTICITIES AND VALUES OF TRAVEL TIME

A.S. Fowkes, N. Sherwood, and C.A. Nash

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ABSTRACT

FOWKES, AS, SHERWOOD, N & NASH, CA (1993). Segmentation of the travel market in London: estimates of elasticities and values of travel time. *ITS Working Paper **345***, Institute for Transport Studies, University of Leeds, Leeds.

This paper reports background research carried out for an ESRC funded research project entitled "Assessing the Benefits and Incidence of Road Pricing in London". The first two stages of this work are reported here. The first stage was to segment the market for car use in Central and Inner London according to the salient characteristics of users. The second stage was to make estimates of the range of probable values of time and elasticities for each segment of the market using secondary data. A thorough literature search was undertaken and we have liaised with other relevant work in progress.

The results of our distillation of what we have found/borrowed are given in section 3. Own price elasticities of demand are presented disaggregated by mode and journey purpose. In the case of car, latest evidence emerging from the DoT study of road pricing in London has been included, showing how elasticities might be expected to rise as the toll is increased radically such as to have severe `income effects'. Values of Time are presented disaggregated by mode, journey purpose and household income group. There is a difficulty, however, in using these values in mode choice transport models and this is discussed in Section 4. Section 5 presents conclusions and discusses application of the results of this paper in the ESRC project. Section 6 lists references and Section 7 is an Appendix containing brief highlights from many of the source articles consulted in our literature review.

KEY-WORDS:

Contact: Tony Fowkes, Institute for Transport Studies (tel: 0532-335340).

SEGMENTATION OF THE TRAVEL MARKET IN LONDON: ESTIMATES OF ELASTICITIES AND VALUES OF TRAVEL TIME.

1. INTRODUCTION

In 1991 the Institute for Transport Studies began an ESRC funded research project which aimed to explore the magnitude and incidence of the benefits and costs of road pricing to travellers, using secondary data and an area-wide model. The model, based on those already in use in Edinburgh and Bristol, illustrates the interaction between supply and demand by reflecting the effects of congestion and overcrowding on travel behaviour, as well as the effects of traffic volumes on road speeds. By incorporating road user charges, it is hoped that the model will be able to rapidly identify the implications of different charging structures in London at a strategic level.

The first stage in the research has been to identify the sensitivity of the demand for travel to price, particularly the demand among car users for road space. The performance of road pricing is heavily dependent upon these demand elasticities. If they are too low, then the efficiency gains of road pricing may be small relative to its implementation costs.

The consequences of road pricing could take several forms including retiming of trips, rerouting, modal transfer, changes in origins and destinations, reduced propensity to travel, and changes in land-use. The incidence and distribution of these effects among different traveller groups with different values of travel time will be explored in the model runs.

This paper discusses progress with preliminary stages of the project; the segmentation of the travel market in London according to the salient characteristics of users, and the estimation of the probable values of elasticities and values of in-vehicle travel time for each segment of the market using available secondary data. The paper ends by discussing what values of time to use when forecasting travel choices.

2. SEGMENTATION OF THE TRAVEL MARKET IN LONDON

Current strategic models (as used in Edinburgh and Bristol) operate by producing base trip matrices for 11 categories of trip:

a.Home based journeys to work by workers from car owning households
b. Home based journeys to work by workers from non-car owning households
c. Home based journeys to education from car owning households
d. Home based journeys to education from non-car owning households
e. Home based social journeys from car owning households
f. Home based social journeys from non-car owning households
g. Home based shopping journeys from car owning households
h. Home based shopping journeys from non-car owning households
i. Employers' business
j. Other non-home based journeys by car owning households
k. Other non-home based journeys by non-car owning households.

These matrices are input to the logit model in the demand process which adjusts trip frequency, destination, mode and time of day according to changes in generalised cost. The actual adjustments undertaken and their hierarchy varies by trip category, with some elements being more sensitive to changes than others.

Unfortunately the London START model developed by the MVA Consultancy, uses a quite different (and less helpful) categorisation of journey purposes

l. Home based work (indicating home based employers business)
m. Home based education
n. Home based other
o. Non home based

In order to incorporate and estimate the response to road user charges, the proposed London strategic model requires that travel data for London include level of income and degree of car-use subsidy. The National Travel Survey conducted in 1985/1986 has proved to be the most useful source for all these purposes. Journeys by 1,365 London residents are identified by time of day and purpose, as are household income and sources of subsidy to the traveller. Although the NTS does not hold specific information on the origins and destinations of journeys, it does permit disaggregation in terms of inner and outer London zones. ITS possesses summaries of NTS data, and has acquired the full 1985/1986 NTS data tapes from the ESRC Data Archive. Data from the 1981 Greater London Travel Survey is now thought to be too old to be suitable for this purpose and data from the 1991 survey was not available in time.

3.ESTIMATION OF ELASTICITIES AND VALUES OF TRAVEL TIME

3.1 REASONS FOR DISAGGREGATION

A disaggregation on the above basis is required to ensure that the main policy questions and criticisms surrounding road pricing are addressed. Theoretical discussions of the distributive effects of road pricing suggest that there may be clear winners and losers under road user charges. In particular:

a. a group of car drivers may exist with values of travel time high enough for the value of time saved to offset the charge. These may be high income drivers, drivers in the course of work and those whose car is subsidised by their employer;
b. a group of users with lower values of time or income or car use subsidy who continue to travel by car and pay the charge may be worse off;
c. the marginal motorist who may cease to travel by car altogether may be a net loser unless a travel alternative (eg. bus) improves sufficiently to offset their loss;
d. bus passengers and operators may gain directly from increased travel speeds and levels of patronage, although this may lead to problems of crowding if capacity is not adequately expanded.

3.2 CHOICE OF CATEGORIES

In order to estimate responses to road user charges in London, variations in generalised cost formulation among different traveller groups must be made explicit to the strategic model. Two factors operate here: the different values of in-vehicle travel time among different categories of traveller, and differences in their overall sensitivity to changes in cost (ie. their own-price demand elasticities). Values of both factors are believed to vary according to mode, income level and level of travel subsidy.

Disaggregation by subsidy, income level and mode would require that appropriate values be found for each of the trip categories. Sections 3.3 and 3.4 will show that because of a lack of secondary data on travel costs a disaggregation on this basis would not be feasible.

However, a disaggregation of trips by income and subsidy level may be possible if, solely for the purposes of estimating travel costs, we regard all trips as belonging to higher order categories as follows:

a. Commuting trips (home-work, home-education)
b. Leisure trips (home-shopping, home-social, other non-home based)
c. Employers' business.

This disaggregation has often been used where trip purpose has been included in studies of travel costs. There is a good deal of evidence on peak/off peak elasticities by each mode, and rather less (but still sufficient) for business trips.

One problem may exist in the distinction between car owning and non-car owning households. This distinction is included in the model to restrict the availability of the car mode choice within the mode choice model and to allow for differential growth of trip making. Unfortunately, little data exists to distinguish between the two groups in terms of their values of travel time or elasticities.

In summary, it is proposed that the three higher order categories be disaggregated by five travel modes (car, bus, train, tube, walk/cycle) and for each mode, by five bands of household income. It would also be desirable to subdivide these according to the provision of company cars. Section 3.3 of this paper will report those elasticity values which are readily available from secondary sources; and consider the problem of disaggregation by income band. Section 3.4 reports the corresponding values of travel time where, fortunately, it has been possible to estimate values for each of the final mode/income groups directly from other sources.

3.3 ELASTICITIES

The own price elasticity of demand can be defined as the percentage change in quantity demanded by an individual in response to a one percent change in price. If a demand function is estimated using econometric techniques, this can be differentiated to give a formula for "point" elasticity, which may be evaluated for a given level of price. Strictly this looks at infinitesimally small changes in price and quality demanded, but gives an acceptable approximation to the "one percent change in price" definition mentioned earlier. If the change in price is only 1%, it will not matter which price is used as the base; original price p or the new price 1.01p. However, for larger price changes, choice of base will be important. It is expected that road pricing will involve very large proportionate changes to perceived motoring costs and so this is important in our case. The appropriate measure of elasticity to use in such situations is an arc elasticity which uses evidence from large price changes, taking the base price to be the mid point between the initial and final prices. Estimates of these are given for car, but not for the other modes where anticipated price changes are much smaller.

The following sections present a range of elasticity estimates for each mode for a variety of journeys. These are discussed and used to draw up preferred elasticity values. Oum et al (1990) present values which they consider most likely estimates of own price elasticities for several modes based on their survey of recent work. These are used in the following sections, together with estimates from reviews by Kemp (1973) and Goodwin (1988), and individual studies to provide a broad reference area in which estimates can be made.

3.3.1 Car elasticities

Elasticity estimates for car travel (see section 7.1) have been dominated by evidence from fuel price changes, which suggest a range of -0.2 to -0.7 for fuel consumption. However, these results may be confounded by drivers trading down to more fuel efficient cars without any change in mileage driven.

A more reliable measure may be the impact of petrol price on traffic levels. Estimates here show a range of -0.1 to -0.3. On the few occasions where other car costs have been considered (tolls, parking) this elasticity range is supported. The values presented here can be viewed point elasticities operative at the current level of motoring costs.

Suggested point elasticities:

Commuting -0.1 Leisure -0.3 Business -0.1

It had originally been intended to investigate car elasticities further within this project by means of a Stated Preference survey. This was dropped when it became clear that such a survey was being conducted as part of the Department of Transport's "Road Pricing in London" programme. The results of this survey have recently become available, HFA, ITS, ACCENT (1993) and so the following very rough guide to likely values of arc elasticities can be given.

Let the initial motoring costs be p and the new motoring costs including tolls be kp, where $k > 1.2$

Use the elasticities given above but multiply them by $(0.5k + 0.5)$

eg. If perceived user costs were to be tripled, $k=3$ and $(0.5k + 0.5) = 2$, and so our suggested elasticities become -0.2, -0.6 and -0.2 for commuting, leisure and business respectively.

3.3.2 Bus elasticities

Elasticities for bus patronage with respect to fares (see section 7.2) suggest a range of between -0.2 to -0.6.

Suggested elasticities:

Commuting -0.3 Leisure -0.6 Business -0.3

3.3.3 Rail elasticities

Elasticity figures (see section 7.3) suggest a range of -0.4 to > -1.50, which is supported by the majority of studies from elsewhere.

Suggested elasticities:

Commuting -0.5	Leisure -1.5	Business -0.5

3.3.4 Tube elasticities

There are relatively few elasticity measures for underground travel. Within the context of the present study, figures relating to London underground are probably of greatest use (see section 7.4). These suggest that tube travel is less elastic than rail trips, with elasticities in the range -0.1 to -0.7.

Suggested elasticities:

Commuting -0.3	Leisure -0.6	Business -0.3

In practice, it would not make sense to use such differing elasticities for rail and tube where they are serving essentially the same sorts of flow. In practice, then, it would seem more appropriate to use the `tube' elasticities for all rail or tube flows within Greater London and the `rail' elasticities for flows from outside Greater London. This accords with the (limited) evidence of rising elasticities with journey length.

For purposes of the models, all of these elasticities need to be disaggregated into the five income bands. We have not been able to identify any empirical evidence on how elasticities vary with income level, this is a gap which needs to be filled by further research.

3.4 VALUES OF TRAVEL TIME

Many studies have estimated values for in-vehicle travel time in the 1980's, and since. The single most thorough British study was that set up by the UK Department of Transport, reported in MVA, ITS, TSU (1987). The results from this study are especially important in that they were used as the basis for the Department of Transport's revision of the standard value of time to be used in road scheme appraisal. Tables 1 to 4 present values of time by mode, journey purpose and income based on the results of that study. Values are given in pence per minute at mid-1985 values for income bands also expressed in 1985 pounds.

Table 1: In-vehicle values of travel time for car travel as a function of journey purpose and income

Income group	Employers' business	Leisure	Commuting
-£5k £5k-£10k £10k-£15k £15k-£20k £20k-	4.20 4.44 4.68 5.30 7.80	3.00 3.43 3.54 4.20 5.25	2.58 2.83 2.98 3.30 3.60
Factor for travel in congested conditions	x 1.26	x 1.55	x 1.41

Source: Table 10, Wardman (1986)

Table 2: In-vehicle values of travel time for bus passengers as a function of journey purpose and income

Income Group	Employers' Business	Leisure	Commuting
-£5k £5k-£10k £10k-£15k £15k-£20k £20k-	2.30 2.50 2.80 3.10 4.50	1.50 1.62 1.77 1.92 2.10	1.50 1.62 1.77 1.92 2.10

Source: MVA et al (1987), with the relativity for Employers' Business taken from the Tyne crossing study.

Table 3: In-vehicle values of travel time for rail or tube travel as a function of journey purpose and income

Income Group	Employers' Business	Leisure	Commuting
-£5k £5k-£10k £10k-£15k £15k-£20k £20k-	4.60 6.40 8.00 13.25 20.66	3.40 4.14 5.06 5.98 7.09	2.05 2.50 3.10 8.21 9.64

Source: MVA et al (1987), with the relativity for Employers' Business taken from the Tyne

Crossing study.

Table 4: Values of travel time for walking and cycling as a function of journey purpose and income

Income Group	Employers' Business	Leisure	Commuting
-£5k	4.60	3.00	3.00
£5k-£10k	5.00	3.24	3.24
£10k-£15k	5.60	3.54	3.54
£15k-£20k	6.20	3.84	3.84
£20k-	9.00	4.20	4.20

Source: Table 2 of this report, doubled as recommended in MVA et al (1987).

4.WHICH VALUES OF TIME ARE APPROPRIATE FOR FORECASTING MODE CHOICE?

4.1 BACKGROUND

At first glance it might appear that by having a consistent set of demand elasticities by mode and mode specific values of in-vehicle time we could predict changes in mode split resulting from changes to modal costs and in-vehicle times. To some extent this will be true insofar as if we have just two main modes, then if our elasticities and values of time correctly give the new demand for the mode affected by the changes (eg. the car mode by the introduction of road pricing) then the consequent changes to the demand of the alternative mode might be surmised, particularly if the effect on total market size can be reasonably predicted.

However, what we really need are the cross-elasticity effects or a proper mode split model. In practice, knowledge of cross elasticities is very weak. They may be expected to vary greatly depending on the mix of alternatives available. The best way to get at the cross-elasticities is to use a mode-split model, and so we will consider this next, as being our best way forward.

A mode-split model gives the proportion of travellers using each mode as a function of the costs, journey times and other attributes of each mode, using knowledge of travellers relative valuations of these attributes one to another. In written form these relative valuations are usually given in relation to cost, so that they appear in money terms per unit of that attribute, e.g. a value of time of 3 pence per minute. The functional form used will be a cumulative probability function, the most usual being the logit form.

Among the parameters for which estimates are required are mode specific values of in-vehicle time. It would appear that we have such things set out in section 3. However, the values given there were values typical of users of that particular mode. These values will be reflecting not just the relative nuisance of travel time spent in that mode, but also the relative incomes of users of that mode. Hence bus users are typically found to have lower values of in-vehicle time than car users, while bus travel time is generally regarded as more unpleasant than car travel time. The answer, of course, is that the lower incomes of bus users have pulled down their average values of time. This could only partly be allowed for by the MVA, ITS, TSU (1987) Value of Time Study, since the income question asked for gross household income, which might be unevenly spread over household members. We have good reason to suppose that if the bus users had to use car, their values of travel time would fall, whereas if the car users had to use bus, their values of travel time would rise.

4.2 EVIDENCE

The evidence we seek should come from suitable mode choice studies, where respondents have to choose between alternative modes on the basis of various attributes including time and cost. Revealed Preference studies can be used, but these usually give very imprecise estimates. Much more precision is gained from using Stated Preference hypothetical choice experiments. We know of many such mode choice studies, but most assume the same value of time for all modes, a so-called generic value of time. Some other studies which do estimate separate coefficients for in-vehicle time for each mode are for contexts not suitable for our present purpose, or are commercial-in-confidence and unknown to us.

However, we do know of two studies which will provide us with a suitable set of values to use. The first was carried out for the Network SouthEast sector of British Rail, and is confidential to them. We cannot report any values here, but we can say that they are consistent with the pattern of the values from the second study, which we are able to present. This second study was conducted in Nottingham in Autumn 1990 for Nottinghamshire County Council (Preston and Wardman, 1991). Mode specific values of time, in Autumn 1990 prices, were found as follows:

Bus In-Vehicle Time	4.37 p/min
Car Free-Moving Time	3.08 p/min
Car Congested Travel Time	5.21 p/min.

From the above we can see that bus travel does indeed have greater disutility than ordinary car driving, but not as much disutility as time stuck in traffic jams. This latter point is not surprising as waiting time for buses has also typically been found to have more disutility than bus in-vehicle time, and the two cases are perhaps comparable. As a rough rule we can say that car and bus in-vehicle times should be in the ratio 1 to 1.5, with rail travel somewhere between, say 1.3. Walking and cycling would typically be given twice the bus value of time (MVA, ITS, TSU, 1987), so say 3.0. Table 5 shows these conjectures for easy reference.

Table 5: Relativities of values of time for use in a mode choice study

Base Car = 100	
Mode	Relative VoT
Car	100
Rail	130
Bus	150
Walk/cycle	300

Car in jam	200

4.3 USE

In order to use the results in this section the following procedure is here recommended. Firstly, determine the appropriate value of time for the people involved, using tables 1 to 4. For example, if we wish to determine how road pricing might affect users of a particular corridor into a city centre we should judge their incomes, and allowing only for inflation, look up 1985 values of time from Table 1. These travellers will be tempted to move to an alternative mode as the disutility of car rises to the level of utility of that alternative mode for the current car user. This disutility will have a time component which will need valuing. This is done by consulting Table 5 to find the appropriate value of time for the alternative mode. For example, if bus is the alternative, the value of time used should be 50% higher than that being used for car free flow time. If some of the car travel time is known to be spent in traffic jams then a value of twice the ordinary car value of time can be used for that portion.

In the absence of mode-specific constants, it might be expected that when the disutilities of the two modes become equal then 50% of car travellers will have switched to the alternative. However, reality is going to be more complicated. Firstly, there will already be some travellers using the alternative mode in the base position. Secondly there will be mode-specific constants, and these are unlikely to be transferable either between persons or situations. A particular problem arises, as here, where mode-specific values of time have been estimated. Unless there is a wide spread of journey times in the estimation data set, estimates of mode m ASC and mode m VOT will be highly correlated, and quite possibly poorly estimated.

A properly calibrated mode choice model for this particular situation would deal with all the above problems. However, the degree of success may be debated. Where this option is not open to us, we should try to simply model the base position so as to replicate mode split at that time. Given the other values taken from tables, discussed above, this can be achieved by adjusting relative ASCs. For just two modes a simple logit model will suffice, but for more than 2 modes an hierarchical logit model should be used. In this way mode split percentage effects may be determined.

5.CONCLUSIONS AND APPLICATION IN THE CURRENT PROJECT

The guidance and values offered in this paper are based upon the data currently available. In the subsequent major stage of the current project we have drawn on the advice given in this paper. It was decided to carry out our experimentation using the MVA START Model (Bates et al, 1991, and MVA, 1992). This imposed several limitations on us, but met the requirement specified at the end of Section 4, namely for a hierarchical logit model. We were able to input differential values of time by journey purpose and household type, based on the results of this paper. The problem of values of time for mode choice, discussed in Section 4, was overcome by using a single value of in-vehicle time, except in the case of rail where there was an overcrowding penalty. Since cars in London are often in jams, an `average' value for car from Table 5 would probably not differ much from those shown for other modes.

This paper has provided values both for input to later work, and to compare later results against.

Brief summaries of the results found in each reference in the literature are listed in the appendix (Section 7). We hope the work contained in this paper will be of benefit to a wider audience and several copies of earlier versions have been made available to other researchers. This paper has been revised, however, in order to provide the best possible basis for the purposes of this project. In particular, the results of HFA, ITS, ACCENT (1992) were particularly eagerly awaited and we wish to incorporate lessons learnt from these fully into the present project. Hopefully research in this area in the future will be rapid, so that this note, even in revised form, will soon become out-of-date.

6. REFERENCES

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PRESTON, J., and WARDMAN, M. (1991) Forecasting motorists long term behaviour in the Greater Nottingham area. University of Leeds, Institute for Transport Studies, Working Paper 322.

WARDMAN, M. (1986) Route choice and the value of motorists' travel time: empirical findings. ITS Working Paper 224.

7. APPENDIX

7.1 CAR ELASTICITIES

ATKINS, S.T. (1985) Traffic control through pricing: the case of Southampton's Itchen bridge. University of Southampton.

Toll bridge charges

Peak	-0.12 to -0.37
Off-peak	-0.17 to -0.37

BAJIC, B. (1984) Choice of travel mode for work trips: some findings for metropolitan Toronto. International Journal of Transport Economics 11, 78-96.

Car operating and parking costs

Income	Elasticity
$10,000	-0.14 to -0.88
$20,000	-0.08 to -0.55
$30,000	-0.04 to -0.31
$40,000	-0.02 to -0.16

BLAND, B.H. (1984) Effects of fuel price on final use and travel patterns. LR1114, TRRL.

Fuel cost (vs consumption)

Short term	-0.50
Long term	-0.75

BONSALL, P.W., and CHAMPERNOWNE, A.F. (1976) Some findings on elasticity of demand for petrol. Traffic Engineering and Control, October.

Fuel cost (vs mileage)

Commuting	-0.50

COMMISSION OF THE EUROPEAN COMMUNITIES (1980) Interim report of the special group on the influence of taxation on car fuel consumption.

Fuel cost (vs consumption)

Short term	-0.20
Long term	-0.40

DONNELLY (1985)

Fuel cost (vs consumption)

Short term -0.14
Long term -0.67

DROLLAS, L.P. (1987) The demand for gasoline - a reply. Energy Economics, January.

Fuel cost (vs consumption)

Short term -0.17 to -0.57
Long term -0.52 to -1.81

GELTNER, D., and BARROS, R.C. (1984) Travel behaviour and policy analysis in a medium size Brazilian city. Transport Policy and Decision Making 2, 425-505.

Out of pocket costs

Commuting -0.16

GOODWIN, P.B. (1987a) Dynamic car ownership modelling. In Rhys, G., and Harbour, G. (eds) Modelling Vehicle Demand, Alternative Views. University of Wales.

Generalised cost

Short term -1.20
Long term -1.90

HENSHER, D.A. (1985) An econometric model of vehicle use in the household sector. Transportation Research 19B, 303-314.

Fuel cost (vs km) -0.22 to -0.52
Maintenance (vs km) -0.01 to -0.09

HENSHER, D.A. (1986) Sequential and full information maximum likelihood estimation of a nested logit model. Review of Economics and Statistics, 68.

In-car costs

Commuting -0.06

HENSHER, D.A., BARNARD, P.O., MILHOPE, F.W., and SMITH, N.C. (1987) F5 freeway study final report, Mcquarie University.

Toll road charges (route choice study)

Private commuter -1.79

Supported commuter	-0.54
Employers business	-0.66
Leisure	-0.73

JONES, P., and HERVIK, A. (1990) Restraining car traffic in European cities: an emerging role for road pricing. Oxford University Transport Studies Unit. TSU Ref: 558.

Cordon toll	-0.22 (Oslo)
	-0.45 (Alesund)

LEWIS, D. (1978) Public policy and road traffic levels, a rejoinder. Journal of Transport Economics and Policy, 12.

Fuel cost (vs traffic counts)

Peak	-0.02 (+/- 0.08)
Off peak	-0.37 (+/- 0.20)
All day	-0.07 (+/- 0.05)

MANNERING, F.L. (1986) A note on endogenous variables in household vehicle utilisation equations. Transportation Research 20B.

Car operating costs	-0.26

PRESTON, J., and WARDMAN, M. (1991) Forecasting motorists long-term behaviour in the greater Nottingham area. Leeds University, Institute for Transport Studies, Working Paper 322.

Car journey costs	-0.05 to -0.39

PUCHER, J., and ROTHENBERG, J. (1979) Potential of pricing solutions for urban transportation problems: an empirical assessment. Transportation Research Record 731, 19-28.

Fuel cost (vs consumption)	-0.20 to -0.30
Work trips	-0.12 to -0.49
Shopping	-0.88

RYDER, P. (1982) Estimated effects of petrol price and LT fare changes using the GLTS model. Greater London Council, TS Note 113.

Fuel cost

Peak	-0.2

SOUTHWORTH, F. (1981) Calibration of a multinominal logit model of mode and destination choice. Transportation Research 15a, 315-326.

Work	-0.16 to -0.18
Shopping	-0.79 to -0.97

TANNER, J.C. (1981) Methods of forecasting kilometres per car. TRRL Laboratory Report LR 968.

Fuel cost (km) -0.26

VAES, T. (1982) Forecasting petrol consumption. PTRC annual summer meeting, session Q.

Fuel cost (km) -0.13

WEBSTER, F.V., and BLY, P.H. (1980) The demand for public transport. Report of an international collaborative study, TRRL.

Fuel cost -0.08 to -0.20

7.2 BUS ELASTICITIES

GOODWIN, P.B. (1987) Long term effects of public transport subsidy in Glaister, S. (ed) Transport Subsidy, Policy Journals.

-0.38

GRIMSHAW, F. (1984) Public transport fare elasticities: evidence from West Yorkshire. Oxford University Transport Studies Unit, Ref: 246.

Peak -0.18
Off peak -0.58

HALLAM, P. (1978) London Travel Survey 1978. Department of Transport.

Work -0.42
Leisure -0.68

HENSHER, D.A. (1986) Sequential and full information maximum likelihood estimation of a nested logit model. Review of Economics and Statistics, 68.

-0.24

McKENZIE, R.P., and GOODWIN, P.B. (1986) Dynamic estimation of public transport demand elasticities: some new evidence. Traffic Engineering and Control, 27.

-0.15 to -0.40

NATIONAL BUS COMPANY (1984) Public transport demand elasticities. Oxford University, Transport Studies Unit, Ref: 246.

-0.22 to -0.64

OLDFIELD, R. (1979) Effects of car ownership on bus patronage. TRRL Laboratory report 872.

-0.3

PUCHER, J., and ROTHENBERG, J. (1979) Potential of pricing solutions for urban transportation problems: an empirical assessment. Transportation Research Record 731, 19-28.

-0.31 to -0.70

TYSON, W.J. (1984) Evidence on elasticities. Oxford University, Transport Studies Group, Ref: 246.

Peak	-0.3
Off peak	-0.6

WANG, G.K.H., and SKINNER, D. (1984) The impact of fare and Gasoline price changes on monthly transit ridership. Transportation Research 18B, 29-41.

-0.04 to -0.62

WEBSTER, F.V., and BLY, P.H. (1980) The demand for public transport. Report of an international collaborative study. TRRL.

-0.1 to -0.7

7.3 RAIL ELASTICITIES

BAMFORD, J. (1984) Rail elasticities. Oxford University, Transport Studies Unit. Ref: 246.

Commuting	-0.46 to -0.53

CUMMINGS, C.P., FAIRHURST, M.H., LABELLE, S., and STUART, D. (1989) Market segmentation of transit fare elasticities. Transportation Quarterly 43, 407-420.

-0.16 to -0.30

GLAISTER, S. (1983) Some characteristics of rail commuter demand. Journal of Transport Economics and Policy 17.

London trips	-0.74 to -0.9

GOODWIN, P.B., and WILLIAMS, H.C.W.L. (1985) Public transport demand models and elasticity measures: an overview of recent British experience. Transportation Research 19B, 253-258.

London trips	-0.12 to -0.23

JOHNSON, L., and HENSHER, D. (1982) Application of a multinominal probit to a two period panel data set. Transportation Research 16A, 457-464.

-0.08 to -0.75

JONES, I.S., and NICHOLS, A.J. (1983) Demand for intercity rail travel. Journal of Transport Economics and Policy 17.

Inter city	-0.48 to -1.18

McGEEHAN, H. (1984) Forecasting the demand for inter-urban railway demand in the Republic of Ireland, Journal of Transport Economics and Policy 18.

Inter city	-0.37 to -0.40

MORRISON, S.A., and WINSTON, C. (1985) An econometric analysis of the demand for intercity passenger transportation. Research in Transportation Economics 2, 213-237.

Vacation	-1.20
Business	-0.18

OLDFIELD, R., and TYLER, E. (1981) The elasticity of medium distance rail travel. TRRL report LR993.

Commuting	-0.5

OUM, T.H., and GILLEN, D.W. (1983) The structure of intercity travel demand in Canada: theory, tests and empirical results. Transportation Research 17B, 175-191.

Inter city	-1.08 to -1.54

OWEN, A.D., and PHILLIPS, G.D.A. (1987) The characteristics of railway passenger demand: an econometric investigation. Journal of Transport Economics, 21, 231-253.

Short term	-0.69
Long term	-1.08

PUCHER, J., and ROTHENBERG, J. (1979) Potential of pricing solutions for urban transportation problems: an empirical assessment. Transportation Research Record 731, 19-28.

Commuting	-0.3

SEGAL, J.F. (1984) Public transport demand elasticities. Oxford University, Transport Studies Unit, Ref: 246.

Commuting	-0.3
Other	-0.7

WEBSTER, F.V., and BLY, P.H. (1980) The demand for public transport. Report of an international collaborative study. TRRL.

	-0.13 to -1.81

7.4 TUBE ELASTICITIES

BLASE, J.H. (1985) The effect of doubling LT fares. GLTS analysis report 3, Greater London Council.

-0.11

COLLINS, P.H. (1983) The effects of recent LT fares changes. PTRC Summer Meeting Seminar N.

-0.16

FAIRHURST, M.H., LINDSAY, J.F., and SINGHA, M. (1987) Traffic trends since 1970. Economic research report R266. London Regional Transport.

Short term	-0.2
Long term	-0.4

GOODWIN, P.B. (1973) Some causes and effects of variations in the structure of demand for urban passenger transport. PhD Thesis, University of London.

-0.48

HALLAM, P. (1978) London Travel Survey 1976. Department of Transport.

Work	-0.35
Leisure	-0.63

PUCHER, J., and ROTHENBERG, J. (1979) Potential of pricing solutions for urban transportation problems: an empirical assessment. Transportation Research Record 731, 19-28.

-0.16 to -0.86