A non geographically oriented model for modal choice in long distance travel

by

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Abstract

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ABSTRACT

A simple model for modal choice is presented, where the geographical detail has been reduced to a minimum. By aggregating a number of areas represented in this generalised manner, modal choice patterns for the UK in 1968 have been reproduced. This calibration is used to examine the likely impact of the Advanced Passenger train on long-distance car traffic. The model showed a marked sensitivity to cost parameters, however, and an alternative model restricted to a specific route has been developed for further studies.

1. INTRODUCTION

The modal choice behaviour of travellers faced with a number of transport alternatives and wishing to make certain trips is closely concerned with the geographical distribution of journey origins and destinations, the proximity of access and the character of the modes of transport available. Although the variations in modal choice due to any one of these variables may be large, there is a great deal to be gained by simplifying as far as possible.

One way of simply representing relative accessibility, location of journey starts and ends, and the modes of travel used to make them is to average over all the journeys and all the access points to each mode. This is a severe simplification, but little may be lost if a probabilistic model is used to soften its effect.

Let us assume that origins and destinations are scattered randomly over the map, that access points to all modes of long-distance travel are also distributed in a random manner, and that all travellers will choose the main mode that offers the minimum total (time and money) cost for a required journey. These assumptions are a reasonable basis for modelling long-distance trips. For such trips the distance and time involved at the access and egress parts of the journey no longer dominate the total cost, and some simplification of the access/egress stages is reasonable. By restricting our attention to long-distance trips, the uniform random distribution assumed for origins, destinations, and mode access points, becomes a more acceptable assumption.

The minimum total (generalised) cost criterion for modal choice has been used by many authors, in spite of the difficulties inherent in assessing a valuation for time savings for the relevant travelling populations.
These assumptions are adequate for us to formulate many modal choice models for long distance travel, and as we have chosen to study the behaviour of the travel market over various lengths of journey, we set up the modal choice formulae on the bases of a given journey length. A practical difficulty is that the perception of total generated cost by travellers is usually blurred, leading to a greater use of less advantageous alternatives, and reducing the sharpness of discrimination implied by models such as this that have a clear minimum cost criterion built into them.

The advantage of this type of simple model is that new modes of travel can be introduced very easily, and a general view of the consequent behaviour of the travel market can be quickly obtained. If we make use of long distance travel survey data, we can divide the country into broad regions, and by characterising all region-region movement by a national mean 'journey length', and utilising relevant densities of access points, we can attune the model to the UK.

2. DERIVATION OF MODEL CHOICE FORMULAE

For a given main haul mode let us define the density of access points as:- $\phi$

Then the probability $P(x + \delta x) - P(x)$ that the next access point lies between $x$ and $x + \delta x$ km from a particular trip origin will be:-

$$2 x \phi \delta x$$

and the probability that it does not lie in $\{x\}$ to $\{x + \delta x\} = P(x)$

Thus:

$$\frac{\delta P(x)}{P(x)} = 2 x \phi \delta x$$

and:- the probability that access point is greater than $x$ away will be:

$$P(\text{access lies at a distance }> x) = \exp (- x^2 \phi)$$

We must now specify the total generalised cost of travel on each mode (i):

$$a_i = \text{cost/km (time and money) to reach the access point to all modes \(i\).}$$

$$b_i = \text{cost/km (time and money) to travel on mode \(i\).}$$

$$w_i = \text{cost (time and money) required to get on to mode \(i\): having reached an access point.}$$

$$d = \text{total length of journey on main mode (assumed to be the same as the distance between origin and destination).}$$

$$x = \text{distance travelled to reach an access point.}$$

Mode $i$ will be chosen from modes $i$ and $j$ for the main haul part of a trip if the total generalised cost is less by mode $i$ than that by mode $j$. 


By applying the probabilities of equations (1) and (2), the total probability of mode \(i\) being selected from all the available modes will be:

\[
P(i) = \sum \left[ \text{probability of an access to mode } i \text{ in } (x, x + \delta x) \right] x
\]

\[
  \times \left[ \text{probability of next access to mode } i \text{ not in } (0, x) \right] x
\]

\[
  \times \left[ \text{probability of next access to mode } j \text{ not in } (0, x) \right] x
\]

This is precisely equivalent to stating that the probability that

\[ x_j \geq (x_i + C_i - C_j) \text{ for all } j \text{ is:} \]

\[
P(i) = \int_{x_i = 0}^{\infty} \left[ 2 \pi \rho_i x_i \delta x_i \right] \exp \left[ - \pi \rho_i x_i^2 \right] \exp \left[ - \lambda \sum (x_i + C_i - C_j)^2 \right] dx
\]

\[
= \int_{x_i = 0}^{\infty} 2 \pi \rho_i x_i \left[ \exp - \lambda \sum (x_i + C_i - C_j)^2 \right] dx
\]

As \(x\) increases from zero to infinity, the range of these summations will change and consequently alter the integrand: if we rank the indices of the modes in order of increasing values of \(C_i\), then the integral may be broken down into a sequence of integrals over different (and increasing) ranges. If at a specific stage \(K\) is the highest possible current value of the mode index number \(i\) (which ranges up to \(N\)):

\[-\lambda \sum (x_i + C_i - C_j)^2 \]

\[ \text{all } j < k \]
will retain the same limits for summation over the range of \( x \) values defined by \( C_k - C_1 \).

Thus

\[
P(i) = \sum_{K=N}^{K=N} \int_{C_k}^{C_1} x_i \exp \left(-\sum_{j=1}^{j=k} p_j(x_1 + C_1 - C_j)\right) dx
\]

By a straightforward process of partial integration between finite limits, we obtain

\[
P(i) = \varepsilon_i \sum_{K=N}^{K=N} \left(\frac{1}{1=K} \right) \exp \left(-\sum_{j=1}^{j=K} \varepsilon_j (C_k - C_j)^2 \right)
\]

\[
\exp \left(-\sum_{j=1}^{j=K} \varepsilon_j (C_k - C_j)^2 \right) \left\{ x - 2\pi \varepsilon_i \sum_{K=N}^{K=N} \left(\frac{1}{1=K} \right)^{3/2} \right\} \sum_{j=1}^{j=K} \varepsilon_j (C_k - C_j) \exp
\]

\[
\left[ \sum_{j=1}^{j=K} \varepsilon_j C_j^2 - \left(\sum_{1=K}^{1=K} \varepsilon_j C_j \right)^2 \right] \left(\sum_{1=K}^{1=K} \varepsilon_1 \right)
\]

\[
\{ \text{Erf} \} = \left(\sum_{j=1}^{j=k} \varepsilon_j \right) \cdot \left[ c_{k+1} - \left(\sum_{j=1}^{j=k} \varepsilon_j c_j \right) \right] \left(\sum_{j=1}^{j=k} \varepsilon_j \right)
\]
where \( \text{Erf} \left( u \right) = \sqrt{\frac{2}{\pi}} \int_{0}^{u} e^{-t^2} dt \).
(a) Density of terminal weighted in different ways

<table>
<thead>
<tr>
<th>Weighting by:</th>
<th>Population</th>
<th>Area</th>
<th>Trips originating</th>
<th>Simple unweighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 coach/bus</td>
<td>0.0260</td>
<td>0.0289</td>
<td>0.0116</td>
<td>0.0104</td>
</tr>
<tr>
<td>2 rail</td>
<td>0.0720</td>
<td>0.0826</td>
<td>0.0283</td>
<td>0.0293</td>
</tr>
<tr>
<td>3 air</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0003</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

(b) Densities by planning region in 1968

<table>
<thead>
<tr>
<th>Planning Region</th>
<th>Area (sq. miles)</th>
<th>Population (10^6)</th>
<th>θ - Air (/sq. mi)</th>
<th>θ - Rail (/sq. mi)</th>
<th>θ - Coach (/sq. mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>7500</td>
<td>3.3</td>
<td>0.00040</td>
<td>0.0293</td>
<td>-</td>
</tr>
<tr>
<td>East and W. Ridings</td>
<td>5500</td>
<td>4.7</td>
<td>0.00036</td>
<td>0.0534</td>
<td>-</td>
</tr>
<tr>
<td>East Midlands</td>
<td>4900</td>
<td>3.1</td>
<td>0.00020</td>
<td>0.0451</td>
<td>0.0053</td>
</tr>
<tr>
<td>Eastern</td>
<td>7400</td>
<td>4.9</td>
<td>0.00041</td>
<td>0.0410</td>
<td>-</td>
</tr>
<tr>
<td>London and S/E</td>
<td>4200</td>
<td>11.2</td>
<td>0.00071</td>
<td>0.1070</td>
<td>-</td>
</tr>
<tr>
<td>Southern</td>
<td>4900</td>
<td>2.8</td>
<td>0.00020</td>
<td>0.0546</td>
<td>-</td>
</tr>
<tr>
<td>South Western</td>
<td>9100</td>
<td>3.4</td>
<td>0.00033</td>
<td>0.0451</td>
<td>0.0073</td>
</tr>
<tr>
<td>Wales</td>
<td>8000</td>
<td>2.6</td>
<td>0.00038</td>
<td>0.0463</td>
<td>0.0070</td>
</tr>
<tr>
<td>Midland</td>
<td>5000</td>
<td>4.8</td>
<td>0.00020</td>
<td>0.0585</td>
<td>0.0076</td>
</tr>
<tr>
<td>N. Western</td>
<td>3900</td>
<td>6.5</td>
<td>0.00077</td>
<td>0.1275</td>
<td>-</td>
</tr>
<tr>
<td>Scotland</td>
<td>27200</td>
<td>5.5</td>
<td>0.00033</td>
<td>0.0260</td>
<td>-</td>
</tr>
</tbody>
</table>
TABLE 2
Modal splits predicted for different definitions of averaged density of termini

<table>
<thead>
<tr>
<th>Density averaged by:</th>
<th>population</th>
<th>area</th>
<th>LDTP trips in region</th>
<th>simple average</th>
<th>LDTP datum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode: = Coach</td>
<td>24%</td>
<td>12%</td>
<td>26%</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>2 = Train</td>
<td>25</td>
<td>13%</td>
<td>27%</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>3 = Air</td>
<td>51%</td>
<td>75%</td>
<td>47%</td>
<td>76</td>
<td>79</td>
</tr>
<tr>
<td>4 = Car</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The a priori figures for cost were adjusted by 1-2% to obtain this agreement, and in view of the crudity of the calculation of the a priori costs, the fit of these figures is surprisingly good.

The results fell into two categories: the simple averaged densities gave good fits, and the more complex averaging process poorer results.

The simplest (area weighted) density gave a very adequate fit, but the assumption common to all four averaging procedures - of a single averaged length of trip - sharply reduced the value of the fit for prediction as neither Air nor any other expensive and rapid long distance mode could be represented fairly. This specialisation to a single averaged journey length may also have increased the sensitivity of the modal split to small cost changes, as 2% changes in the on-mode cost for a given mode could lead to market share variations an order of magnitude larger for this mode.

3.2 Geographically specialised calibration

We may generalise the market share calculations to cover long distances travel in the UK over various distances by splitting the UK into the 11 planning regions and ascribing a mean length of trip inside and between each such region. Fig 1 shows how such a set of discrete distances can be combined by using weightings derived from the LDTP to give a good representation of the overall distribution of travel by distance, and Table 3 summarises the LDTP data used for this calculation.
### TABLE 3

**Origin - Destination Matrix**

Giving characteristic distances for each journey, and no of journeys as a percentage of national travel derived from the LDTP.

<table>
<thead>
<tr>
<th>Origin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Northern</td>
<td>2(\frac{1}{2})</td>
<td>1</td>
<td>45</td>
<td>90</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100-125</td>
<td>125-150</td>
</tr>
<tr>
<td>2. Yorks and Humberside</td>
<td>1(\frac{1}{2})</td>
<td>3</td>
<td>48</td>
<td>70</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>3. E. Midland</td>
<td>-</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>1</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>73</td>
<td>98</td>
<td>-</td>
</tr>
<tr>
<td>4. E. Anglia</td>
<td>-</td>
<td>-</td>
<td>98</td>
<td>48</td>
<td>73</td>
<td>98</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. S.E. (Net.)</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{3}{4})</td>
<td>73</td>
<td>73</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>450</td>
</tr>
<tr>
<td>6. S.E.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>98</td>
<td>48</td>
<td>73</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. S.W.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>148</td>
<td>173</td>
<td>76</td>
<td>98</td>
<td>173</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Wales</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>198</td>
<td>-</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9. W. Mid.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>73</td>
<td>-</td>
<td>123</td>
<td>148</td>
<td>173</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{3}{4})</td>
<td>8</td>
</tr>
<tr>
<td>10. N.W.</td>
<td>-</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>123</td>
<td>40</td>
</tr>
<tr>
<td>11. Scotland</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1(\frac{1}{2})</td>
<td>-</td>
<td>152</td>
<td>10(\frac{1}{2})</td>
<td>73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Origin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Scotland</td>
<td>148</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The table entries represent the characteristic distances for each journey, with the destination numbers indicating the percentage of national travel derived from the LDTP.
A 'characteristic' distance for Scotland as a whole is about 125 miles. This gives a disproportionate no of journeys in this distance band. A better representation is to split Scottish travel into 2 parts: 2/3 of travel in 50-75 band and the remainder in 200-299 band.

All routes carrying < 2% of national traffic were discarded (this loses 4½%, including all travel of "350" miles and forms < 1% of total LDTP Travel). Summing travel, by distance band:

<table>
<thead>
<tr>
<th>Distance Band</th>
<th>Initially</th>
<th>Re-allocating Scotland</th>
<th>AGB L.D.T.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 - 49</td>
<td>41 3%</td>
<td>41 3%</td>
<td>44</td>
</tr>
<tr>
<td>50 - 74</td>
<td>12 2%</td>
<td>10 2%</td>
<td>24</td>
</tr>
<tr>
<td>75 - 99</td>
<td>10 2%</td>
<td>10 2%</td>
<td>12</td>
</tr>
<tr>
<td>100 - 149</td>
<td>25 2%</td>
<td>10 2%</td>
<td>10</td>
</tr>
<tr>
<td>150 - 199</td>
<td>3 2%</td>
<td>3 2%</td>
<td>4</td>
</tr>
<tr>
<td>200 - 299</td>
<td>2</td>
<td>5 2%</td>
<td>5</td>
</tr>
<tr>
<td>300 - 399</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>400 +</td>
<td>3 3%</td>
<td>3 3%</td>
<td>-</td>
</tr>
</tbody>
</table>

The characteristic distances are intended to convert the LDTP data from a regional basis to a national basis, split up into distance bands.

When the Scottish travel is redistributed, the distance-based regional figures give a good approximation to the overall LDTP figures as is demonstrated in Figure 1.

Individual calculations may now be made to find the market shares held by each mode for each of these characteristic distances, with the appropriate terminal access densities. The shares may then be combined to give a better representation of the UK travel market. The results of this calibration are shown in Fig. 3. The lowest distance band (25-49 miles) and the highest (over 400 miles) are clearly unreliable; neither the basic data nor the calculations can give reliable results at these two extremes of distance due to the sparsity of the data and the probable confusion with commuting journeys.

The results show the dominance of 'car' travel up to 300 miles, with train and bus taking a smaller and smaller share of the market as the length of journey increases. The calculated market shares are in reasonable agreement with the LDTP (also shown in Fig. 3), and the consistently underestimated share of the market taken by 'coach' in
due mainly to the use of a single averaged valuation of time for all travellers. As 'coach' is generally both cheaper and slower it is used mainly by low income travellers, thereby producing this underestimation. By using a single averaged valuation of time, any systematic variations of trip length with income are also lost.

The results are (omitting < 50 mile trips)

<table>
<thead>
<tr>
<th></th>
<th>Calculated &gt; 50 miles</th>
<th>LDTP &gt; 50 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coach</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Train</td>
<td>16%</td>
<td>13%</td>
</tr>
<tr>
<td>Car</td>
<td>65%</td>
<td>71%</td>
</tr>
</tbody>
</table>

These are in fair agreement, but the failure of air travel to show up in either set of data shows how poor this approach is for prediction purposes, in spite of the potential for easily including new modes of long distance travel into the model calculations.

A further calibration comparison may be drawn from the LDTP data (ignoring distance bands and the consequent regional combinations) by examining the calculation results as a function of income rate. The results are shown in Fig. 1. It can be seen that the 'air' and 'rail' modes effectively split the market between them for incomes above £3,500pa in 1968.

4. AN ILLUSTRATIVE APPLICATION

To show the kind of effects that this model can produce, let us add a new travel mode in the form of a high speed train with the approximate characteristics of the Advanced Passenger Train (APT) proposed by British Rail. At a point in time when 30 access stations to APT are assumed to be working we may study the effect of the APT on the market shares of each mode. In Figs 4(i) and (ii) we show the variation in market share as a function of income rate for both the medium haul and the long haul markets. The cost of travel on the APT was taken to lie between current rail costs (including time costs) and current air costs as two extreme assumptions, and these two limits are shown in Fig. 4. The results of assuming a medium cost, 15% above rail and 7% below air; are also given.
The results show that APT could obtain a very large proportion of the travel market under favourable cost assumptions, and is likely to make a strong impact even when a pessimistic view is taken of the probable costs. This model therefore pinpoints the areas of the market sensitive to APT: if all travellers have a sharp perception of their costs. In practise trip end (access and egress) effects and frazz traveller perceptions aim softer this sharp discrimination, but this qualitative indication of market response is illuminating.

The modal choice model described is of limited value due to its undue sensitivity to cost parameters: this sensitivity is due mainly to the clear cut assumption that travellers will always view their costs accurately, and decide positively on the basis of only the costs included in this model. Although the general behaviour of the model is reasonable, and adequate fits to data may easily be found, this over sensitivity limits its use to such general applications as that shown in Fig 4. This work has also served to show that a less sharp discrimination of the generalised costs of travel is appropriate for modal choice models for long distance travel. As a result, such a model has subsequently been constructed\(^2\) and applied.

This subsequent model was restricted to single routes as the global, non geographical, approach had been shown to be unduly sensitive for further studies. In order to provide suitable input data for the use of the new 'route' model\(^2\), it was necessary to obtain modal split data for long distances travel. The Long Distance Travel Panel yielded inadequate information for any very useful geographical data. The degree of linkage between different planning districts and the Greater London area is shown in Fig. 5.

A considerable amount of data on inter-urban travel is already available in the records of transportation surveys, but some of the surveys were made some years ago, and in most cases the coverage of non-car travel modes was inadequate for the present purpose. The requirement for the further study of long distance travel was for consistent figures for travel by each of the available modes between some specific pairs of areas, especially the larger towns which might be expected to offer the best opportunities for new modes. Since the requirement could be satisfied by available transportation survey records, a new ad hoc survey was needed. In order to cover all travel between selected pairs of areas, a cordon survey method is considered to be the most satisfactory.

If a cordon line is drawn on a map between two towns, and if all available transport routes crossing this cordon are covered by means of a suitable survey, all trips between the pair of towns will be represented. For example, if a cordon is drawn from the East
coast to the West coast along the Scottish border representative data is obtained for travel between every town in Scotland and every town in England. A small number of carefully placed cordons can therefore provide data on travel between a large number of pairs of towns.

In order to define sensible cordons for the collection of long distance travel data, an elementary gravity model was fitted to the external cordon movements recorded in the London Transportation survey. The 16 largest movements (over about 30 miles) were used for car travel data.

The resultant benefit was found to be \( N = 2.4 \pm 0.3 \) for a formula trips = \( \frac{P_i P_j}{d_{ij}} \)

The inclusion of coach and air data, on a crudely corrected scale, produced a figure of \( N = 1.9 \pm 3 \), indicating that the inclusion of this data did not change the value of \( N \) unduly. (Little weight should be attached to the 1.9 figure, as it is known that >80% of travel to the range of destinations used would be by car, by reference to the 1968 LDT Panel). A BBE study gave 1.34 for rail volume.

A ranking of major intercity movements was made, using \( R = \frac{P_i P_j}{d_{ij}} \) as an index of size. The populations used from the 1961 Census, and the definitions of the conurbation are taken from the 1966 sample census. No significant errors in ranking are likely to be caused by the comparatively small changes in population over 1961-1968, in view of the fact that the road distances used refer to town or conurbation centres, and this introduce errors of at least the same order of magnitude.

Movements were ranked by \( R \)-value, for interconurbation, intercity and city-conurbation movements. All very short distance movements were dropped; as heavy commuter traffic would be likely, and because distances of less than \( \sim 35 \) miles are not of great interest in a long-distance context.

Movements of \( R \geq 20 \) were shown plotted in Figure 6, and should the concentration of movements within the triangle London (Birmingham) Liverpool, Leeds. Due to the extreme unsophistication of the index, this should not be taken too seriously as an index of long distance travel: the major value is in the pinpointing of routes on which high density intermediate distance flows would be expected.
These movements may be grouped in intervals of \( R \), and 77 interview points can give a full coverage right down to \( R < 20 \), and leaves only a few gaps at \( R = 10 \) and \( R = 5 \). Suitable cordons were defined first in terms of specified points on specified roads.

Four cordon lines were proposed:

1. across Northern England, north of Newcastle, requiring six points
2. an arc between Liverpool and Birmingham
3. a quadrant isolating Cardiff/Swansea from England, requiring seven points
4. a semicircle round London requiring nineteen points.

A national screen line survey over all modes was commissioned by the Department of the Environment, and cordons one and two were covered in 1971 and 1972 for all modes.

5. SUMMARY

The prime interchanges of travel demand shown on Fig. 6 (ranked from 1 to 24) show that the range of breakpoints in the market for the advanced passenger train still cover the prime cordons of movement: the screen line survey was required to obtain the model balance of these movements in order to compare APT with other possible new modes. The subsequent work on the corridor model\(^2\) was calibrated using data collected by G R Leake\(^4\) of Leeds University on a number of long distance corridors with both rail and air services, and was applied\(^3\) using the same set of data.

Although the cost of most possible new modes limits their probable lines to the few main routes, several of which were studied in Refs 3, 4, the upgrading of existing networks on a systematic basis is not readily analysed on an access/egress corridor of the type put forward by Wigan for the program of references 3 and 4, and a broader, non-geographic approach should be found if possible. Surprisingly, in view of the sensitivity of the model described in this paper, the market areas most susceptible to APT seem to have been neatly delineated, and further work on these lines would seem to be worthwhile, making use of
The mass of data from the screen line survey\(^{(4)}\) has recently become available, and the unreliable but indicative results of the Long Distance Travel Panel can now be replaced by the pending conclusions of the National omnibus survey being undertaken by the Statistics Directorate of the DOE and by the 1972 National Travel Survey.

Of special importance is the recreational or holiday journey, and the tentative results from the April/June quarters of the 1968 LDTP returns are shown in Fig. 7. There are three different areas of competition:

1) 25-150 miles: work is approximately equal to Holiday travel and both are swarmed by pleasure travel and visits in the ratios 10:10:80
2) 150-300 miles: (ABT's but market) here are widely differing levels of competition
3) > 450 miles: work is approximately equal to pleasure and visits and the ratio become 25:50:25

It is clear that the intermediate distance travel market is open to a wide range of competitive services, and also that holiday trips dominate for the longest journeys.

For further work it would be well worthwhile making a special study of recreational travel and the effect of group size on the choice of mode for long journeys: this would require some supplementary follow up studies to extract time trends.

It is also suggested that less geographically specific models be built to analyse the travel market by journey purpose over the country as a whole, as concentration on single corridors likely to give unrepresentative results for recreational travel.

An approach midway between Wigan's access/egress corridor model and the present paper is recommended.

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7. REFERENCES

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Fig. 1. Modal Split at different values of time, for travel panel and calculated figures.
Fig. 2. DISTRIBUTION OF TRAVEL BY JOURNEY LENGTH

Fig. 3. MODAL CHOICE BY JOURNEY LENGTH
Fig. 4. MODAL SPLIT AS VALUE OF TIME CHANGES
E14.7: How serious are your symptoms this last month?