THE CHARACTERISTICS OF RAILWAY PASSENGER DEMAND

An Econometric Investigation

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The aim of this study is to develop a methodology for establishing the impact of a number of economic factors on the demand for inter-city rail travel in Great Britain, and to assess their relative importance by the use of time series data and the tools of econometrics. Our analysis is centred on twenty London-based inter-city rail flows: those to Bath, Birmingham, Bristol, Cardiff, Carlisle, Edinburgh, Glasgow, Leeds, Leicester, Liverpool, Manchester, Newcastle, Norwich, Nottingham, Plymouth, Preston, Stockport, Swansea, Swindon and York. We use data on four-week ticket sales recorded by British Rail's National Passenger Accounting and Analysis System (NPAAS) over the period 1973 to mid-1984.

A number of studies into the determinants of the demand for rail travel have been completed in recent years. Many of these remain confidential to British Rail (BR); but two published studies of particular relevance to the results presented here are those of Fowkes *et al.* (1985) and Jones and Nichols (1983).

Fowkes *et al.* pooled annual data for the period 1972–81 for routes connecting the main conurbations, and sought to explain the percentage change in traffic for each year on each route. Thus they obtained a single coefficient estimate for each explanatory variable which, implicitly, was assumed to be common for all the flows being pooled. The use of annual data enabled them to use regional values for variables denoting external economic influences, such as employment, earnings, and car ownership. Estimation was carried out on the full sample of routes and for three sub-categories, one of which was London-based routes.

Jones and Nichols (1983) used regression analysis to explain the total demand for rail travel in terms of a number of economic factors. Their work was based on NPAAS four-week data on seventeen of the London-based flows used in this study, for the period 1969 to 1977. The estimated elasticities obtained by us can thus be compared with those obtained by Jones and Nichols, though it should

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be appreciated that the two data periods have only a minor overlap.

The first section of this paper discusses the quality of the data base available. The explanatory variables used in the ensuing analysis are discussed in detail in section 2, and details of model specification are given in section 3. Section 4 contains the main results of the study; a summary, together with the main conclusions, is given in section 5. Where possible, detailed mathematical or statistical proofs have been omitted. A fuller paper is available from the authors.

1. DATA

NPAAS is designed to record on a four-week basis the number of passenger ticket sales between pairs of BR stations. A complete record, however, is not possible, since a number of sales flows go unrecorded by NPAAS. The main source of omission is "blank" tickets (that is, tickets written by travel agents or hand-written at station booking offices); but records may also be lacking or incomplete because of faults in ticket issuing machines, and NPAAS does not detail excess fares, paytrain receipts, railcards, and miscellaneous journeys (for example, on Golden Rail holidays and Britrail passes).

An additional problem is that ticket sales are recorded by NPAAS between two points which may differ from the origin and/or destination of the traveller. For example, a rail traveller wishing to go from Ilkley to London is obliged to re-book at Leeds, and thus the journey will appear in the data as a Leeds-London sale.

The difficulty becomes more acute if changes in the fares structure lead to changes in the pattern of through booking. This occurred particularly after the introduction of special low-price tickets (such as the London Savers), which were frequently available only for travel between principal stations. Thus re-booking at principal stations was encouraged. For example, from the introduction of Savers till May 1985, a rail traveller wishing to travel from Brighton to Leeds would find the cost of the journey reduced if it were booked on two separate tickets, Brighton-London and London-Leeds, rather than on the full second class fare for the entire journey.

A further problem is the increasing use of railcards. Tickets purchased with railcards are simply recorded as half-price full fare tickets, so it is not possible to judge how far they affect the data.

A recurring concern throughout this study was that for all these reasons the proportion of journeys made that were recorded in the data base may have declined progressively over the sample time period, so some of the results should be interpreted with caution. This question is examined again in section 4.

2. EXPLANATORY VARIABLES

We are seeking to explain the main determinants of the demand for rail travel, defined as "single journeys between two stations" and measured as four-week totals. A substantial number of relevant explanatory variables were considered for this analysis. They are now discussed on an individual basis.

(i) Rail fares

The level of fares has consistently been found to be a highly significant determinant of the volume of inter-city rail travel. In this study the fare level was defined as unweighted average revenue per passenger journey; that is,

$$F_t = \frac{\sum_i (Q_{it}F_{it})}{\sum_i Q_{it}}$$

where Q_{it} = journeys made on ticket type i in period t, and F_{it} = price in period t of tickets of type i. To allow fares to be expressed in "real" terms, F_t was deflated by the retail prices index (1973 = 100).

As constructed, this fares variable represents a mix of a large number of fares, and thus takes into account changes in the types of tickets available and in their sales. It suffers, however, from the disadvantage that it contains a good deal of variation unconnected with genuine price movements. "Fares" can vary without any change in ticket prices because of:

(a) seasonal variation (for example, more business travel on first class tickets takes place at certain times of the year);
(b) changes in service quality offered by competitors (for example, first class travellers may be attracted to air services or second class travellers may be attracted to coach services);
(c) changes in the conditions relating to ticket types (for example, Savers may be withdrawn on certain early morning trains);
(d) the introduction of special travel offers such as railcards.

The problem mainly affects the second class fare (and hence total fare in the aggregate relationship). It could, in principle, be avoided by using fixed weights determined at some base date. This was considered; but the relatively large number of different ticket types, some of which were in existence for only part of the study, made it difficult to establish appropriate weights. In any case, the choice of a base date is necessarily arbitrary, and frequent revision would be required in response to the changes noted above. It was therefore decided to use average revenue as the measure of the fare level, notwithstanding its limitations.

(ii) Gross Domestic Product (GDP)

For a variable to reflect macro-economic activity, we considered Gross Domestic Product (GDP), Real Personal Disposable Income (RPDI) and Consumer Expenditure (CE). Intuitively, one would expect any of these to be a reasonable variable for explaining variations in rail journeys generated by changes in the national economy. For this study GDP, seasonally adjusted and at 1980 factor cost, was the chosen variable. On completion of the study, however, the effect of this choice was examined by substituting RPDI and CE for GDP in a sample of separate regressions. The results were not changed to any significant degree.

Since our model is based on time periods of four weeks, it is important that the Central Statistical Office publishes few monthly series on macro-economic activity that are relevant to this study. Retail sales data, both by volume and by value, are published monthly, but data relating to GDP, CE, and RPDI are gathered only on a quarterly basis.

To allow the maximum degree of disaggregation for this study, monthly data for GDP were generated by a technique proposed by Chow and Lin (1971). Given the value of a series of flows during each quarter for *n* quarters, and the value of a related series for each month, best linear unbiased estimates of the first series can be obtained for the 3*n* months by regression on the related series.

Retail sales, by volume, was found to be highly correlated with GDP, yielding a correlation coefficient of 0.80 based upon quarterly data over the period 1973 (1) to 1984(2). GDP was therefore regressed on retail sales by volume (RSV). Then, using monthly seasonally adjusted data on RSV, we interpolated monthly values for GDP from this equation and subsequently "adjusted" them to ensure that the aggregate value of the three monthly figures equalled the known quarterly figure.

(iii) The High Speed Train

An important group of variables are those that measure service quality, frequency and speed in comparison with BR's competitors (car, coach and, on some services, air). Major reductions in journey time occurred on many main inter-urban flows as a result of the West Coast Main Line electrification to Glasgow, completed in 1974, and the progressive introduction of High Speed (125 m.p.h.) Trains (HST), which began in 1976. The new trains also brought improved levels of service and rolling stock, as well as a more conspicuous level of British Rail marketing activity.

The effect of the West Coast Main Line electrification in our analysis was negligible for the affected flows. Since our data period commenced not long before the electrification was completed, it was felt that its main impact had occurred by early 1974, and so its role was ignored when estimating the flows from London to Preston and Glasgow.

The introduction of the HST, however, dwarfed all previous changes in service quality and speed for the flows affected. Since the major improvements in journey time, departure frequency and service quality occurred jointly, it is not possible to isolate their individual influence on the increase in rail custom which followed the introduction of the HST.

A characteristic of the growth of the demand for many new products is that, once started, the rate of growth is very high during the early stages of development, but then gradually declines and reaches a saturation level (or asymptote). Similar growth patterns may be observed in various cases of biological and population growth. There are a number of ways of incorporating it into a statistical model. For this study a negative exponential trend was selected for incorporating the impact of the HST over a number of time periods.

The Gauss-Newton method was used to derive non-linear regression estimates of the parameters of the model which incorporated this non-linear term to explain the growth in demand for rail travel due to the introduction of the HST.

(iv) Time Trend

A linear time trend was included in the analysis to capture the impact on rail travel over the sample period of certain underlying trends for which reliable monthly data were not available. Of particular importance are the following:

(a) growth in car usage;
(b) local (that is, provincial centre catchment area) levels of economic activity;
(c) regional growth (or decline) in population.

(a) Car usage

Cars undoubtedly represent an important source of competition for BR, but it is difficult to find the appropriate variable to measure car competition. Initially an index of (real) petrol prices was used in this study to reflect the variable cost of motoring, but its explanatory power was negligible. It is generally accepted that the price elasticity of petrol is very low, but a number of other factors clearly reduced the impact of rising petrol prices on the cost of motoring during the 1970s. Briefly, they were:

(1) a move by consumers towards smaller cars with lower fuel consumption;
(2) the production of more fuel-efficient cars; and
(3) enforced fuel economy through a reduced speed limit.

In addition, improvements in Britain's network of motorways reduced travel time, and thus allowed convenience and speed to be traded off against the higher cost of petrol.

For these reasons, a variable measuring car usage would seem to be appropriate. A monthly index of vehicle kilometres travelled by cars and taxis in Great Britain was incorporated into the regression, but this variable possessed very little explanatory power.

(b) Local levels of economic activity

Local levels of economic activity will obviously have a strong influence on the demand for all modes of travel. If regional economic activity is measured in terms of total employment in the region, one would expect leisure travel by rail to be very responsive to changes in this variable. Its impact on business travel, however, is more uncertain. Most business trips are made by managerial, professional and technical workers; thus it is employment in these categories that is important, rather than total employment.

Monthly data on regional levels of employment are not available, though they can be estimated from published regional rates of unemployment. Data disaggregated by categories of employment are not available.

The only monthly regional measure of economic activity that was available to this study was unemployment data (from which employment data could be estimated) by travel-to-work areas. Over the period of this study, however, there appear to have been substantial underlying changes in the operation of the labour market, and the use of unemployment/employment to reflect local levels of economic activity could be extremely misleading.

(c) Changes in population

Changes in regional population levels will influence the demand for rail travel, and so will the age structure of the population. Regional population data, however, are only gathered in years of the census; intervening years are estimated. For most of the flows considered in this study, changes in regional populations occurred only gradually and were relatively small over the sample period. The exceptions were Liverpool and Manchester, where regional decreases in population were quite marked.

(v) Competition

The main sources of competition to rail travel are the motor car, express coach services and air travel. The impact of air travel, however, is negligible for all routes considered in this study except the very long ones (Edinburgh, Glasgow and Newcastle).

The competitive threat to rail travel from cars was discussed earlier. Airlines on the three routes mentioned, with the introduction of "shuttle" services and increased inter-airline competition, have made substantial inroads into the long-haul routes at the expense of rail travel. The threat to rail travel from coach services, however, is more widespread.

In October 1980 the express coach market in the United Kingdom was deregulated by the Transport Act 1980. This Act presented individual coach firms with complete freedom to enter into direct competition with pre-existing operators (the two main ones were the National Bus Company (NBC) and the Scottish Bus Group (SBG)) on any route at whatever fare, frequency, etc., they desired. Deregulation immediately led to the introduction of many new independent services, and stimulated intense price competition between new and existing operators.

The biggest threat to NBC and SBG services was posed by British Coachways (BC), a consortium of six large coaching firms, which on 6 October 1980 commenced operation of a rival network of services connecting the main provincial centres with London. Their fares undercut those of NBC by a substantial margin, but NBC responded very quickly by matching fares within the week. In the following month rail ticket prices were increased by 22 per cent, though Big City Saver tickets were available on a number of routes which allowed off-peak rail travel at substantially reduced prices for passengers willing to pre-book. A "London Saver" ticket was introduced from Liverpool to London in January 1981, and similar tickets became available from Birmingham and Manchester in June of the same year. The success of the Saver scheme was soon apparent, and low-priced Saver tickets were subsequently introduced on a much greater range of routes.

After deregulation, the NBC experienced a 50 per cent increase in passengers in 1981 over the 1980 level, though total revenue grew by only 31 per cent because of the lower fares being paid on the main routes to London. Overall, NBC departures were 65 per cent higher in 1981 than in 1980, but thereafter remained relatively stable. Notable exceptions are the routes linking London and Cardiff, where departures rose by 236 per cent over the period September

1980 to January 1984, and, at the other end of the spectrum, London and Manchester in 1983 and 1984 showed a net reduction on 1980 levels.

The substantially reduced coach fares on the main routes to London are likely to have had two consequences:

(a) they will have generated "new" leisure travel business; and
(b) they will have encouraged leisure travellers to substitute coach travel for the relatively more expensive rail. It is unlikely that business travel would be affected, since coach travel has always been viewed as an inferior mode of travel to rail, except in special circumstances – for example, in linking provincial cities to Heathrow.

Dummy variables were used to model the impact of deregulation of coach services in October 1980, and of improved air services on the longer routes. Occasionally the coach service dummy variable was augmented by an additional dummy variable to reflect rapid growth after the introduction of Rapide services in 1983.

(vi) Dummy Variables

Dummy variables were used to reflect the impact on rail demand of major events such as strikes. Dummy variables (twelve in all) were also used to account for seasonal fluctuations.

3. MODEL SPECIFICATION

The object of this study is to specify and estimate a single equation model, for each of a number of London-based provincial rail services, which will explain the total demand for passenger rail travel in terms of changes in a number of economic factors. Separate equations will also be estimated to assess the relative importance of those factors in explaining first and second class travel.

It is reasonable to assume that the responses of rail travellers to changing economic conditions are spread over a period of time, and do not occur instantaneously. For example, an increase in (real) rail fares, with all other explanatory variables unchanged, will reduce the demand for rail travel both in the current time period and in future periods. Rail travellers may reduce the number of journeys made, and/or increase their demand for alternative modes of transport which have now become relatively cheaper than rail travel. A similar argument can be used to explain the impact on rail travel of changes in external economic variables, such as the level of disposable income.

At a given price (fare) P_t, therefore, we assume that rail travellers have a "desired" or "equilibrium" level of demand for rail journeys, J^*_t, and that this relationship can be written (in linear form) as

$$J^*_t = \alpha + \beta P_t + u_t, \qquad (1)$$

where u_t is a random disturbance term and, for this particular study, all variables are expressed in natural logs. In general, other explanatory variables will also be present in this demand equation. Clearly J^*_t is unobservable. It may be reasonable to assume that in any time period the demand for rail journeys adjusts partially towards its desired level: that is,

$$J_t - J_{t-1} = \mu(J^*_t - J_{t-1}). \qquad 0 < \mu < 1 \tag{2}$$

where μ, a constant, is the speed of adjustment. If $\mu = 1$ adjustment is instantaneous, whereas if $\mu = 0$ no adjustment takes place.

Substituting for J^*_t in equation (1) and simplifying yields

$$J_t = \eta_0 + \eta_1 J_{t-1} + \eta_2 P_t + e_t, \tag{3}$$

where

$$\eta_0 = \mu\alpha, \eta_1 = (1 - \mu), \eta_2 = \mu\beta, \text{ and } e_t = \mu u_t.$$

Implicit in equation (3) is an infinite geometric lag structure on the independent variable, P_t. It is a simple matter to show this lag structure explicitly. See, for example, Maddala (1977), pages 142–3.

If the disturbances in equation (1) are not serially correlated, then neither will be the disturbances in equation (3), and equation (3) can be estimated consistently by least squares. If the relationship given by equation (2) also includes a random disturbance term, then under the same proviso least squares will remain a consistent estimator of the parameters in equation (3).

As our model is specified in a partial adjustment framework, it should be noted that a common geometric lag is implicit on all the independent variables. In common with Jones and Nichols (1983), we attempted to incorporate polynomial lag structures (as an alternative to the geometric lag) on the major independent variables in our study. However, we found no evidence of any well-defined common polynomial lag structure, whereas the partial adjustment model was often well supported by the data.

A distinction is made in this study between the short-term (s.t.) – that is, immediate – impact on rail demand of a change in an explanatory variable and the ultimate long-term (l.t.) impact after all the lags have worked themselves out. From equation (2) it is clear that the larger the value of μ the shorter will be the "long-term". Since all flows considered in the ensuing analysis produced different values for μ, it follows that the "long-term" varies according to the flow being examined.

4. THE RESULTS

Three demand equations were specified and estimated for each of the 20 London-based flows to provincial centres selected for this study. "Total journeys" was explained by one of these equations; the other two disaggregated the dependent variable into first and second class journeys. Data on all relevant variables recorded in monthly form were adjusted to a four-week basis to conform with the NPAAS data.

Demand equations of the following kind were estimated for each of the flows over the period 1973 to 1984(6) (a total of 149 observations):

$$J_t = \beta_0 J_{t-1}^{\beta_1} G_t^{\beta_2} F_t^{\beta_3} \exp(\beta_4 T_t + \beta_5 S_t + \beta_6 C_t + \beta_7 A_t + \sum_{i=8}^{19} \beta_i D_{it})\epsilon_t ,$$

where

J_t = number of single journeys between two stations;
G_t = index of gross domestic product at 1980 factor cost;
F_t = average revenue per journey (i.e. average fare);
T_t = linear time trend (i.e. $T_t = t$);
S_t = HST variable (see text for method of construction);
C_t = coach competition 0–1 dummy variable;
A_t = air shuttle 0–1 dummy variable;
D_{it} = seasonable 0–1 dummy variable (12 in all);
ϵ_t = random error term.

When the demand equations were specified for first and second class journeys, an additional fares variable was added: that is, both own fare and cross fare variables were included.

The double logarithmic form of the above equation was estimated, and thus the estimated coefficients are also estimated (short-term) elasticities. This particular form of the demand equation implies that all elasticities with respect to the demand for journeys are constant. This assumption was tested, and the results are presented later in this section.

In total, 60 equations were estimated, and clearly a space constraint prevents a complete enumeration of each result and its associated summary statistics. For each equation, the coefficient of determination corrected for degrees of freedom ($\bar{R}^2$) and Durbin's h statistic for testing the null hypothesis of non-autocorrelated disturbances are given in Table 1. With the exception of the Carlisle flow, all values of $\bar{R}^2$ were over 0.78; this indicates that these equations possess a high degree of explanatory power. For 15 equations the hypothesis of non-autocorrelated disturbances was rejected at the 5 per cent level of significance, on the basis of Durbin's h statistic. In two cases this statistic was inappropriate.[1] As an additional measure of the magnitude of any autocorrelation that may be present, in those cases where the hypothesis of non-autocorrelated disturbances was rejected an indication is given of the size of the estimated coefficient of the first-order autoregressive structure of the disturbances.[2] Autocorrelation does not appear to present a serious problem in any equation except, perhaps, in that explaining second class journeys on the Stockport flow.

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[1] The Durbin h statistic may be calculated as

$$h = (1 - \frac{d}{2}) \sqrt{\frac{n}{1 - n \ \widehat{\mathrm{var}}\ (\hat{\beta})}}$$

where $\hat{\beta}$ is the coefficient of the lagged dependent variable, n is the sample size, and d is the Durbin-Watson statistic. It should be noted that it is possible for $n \ \widehat{\mathrm{var}}\ (\hat{\beta}) > 1$; thus, in such a situation, the test is inapplicable. Asymptotically, h is distributed as standard normal.

[2] We believe this is of some interest, in spite of the estimation bias.

TABLE 1

Summary Statistics

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	$\bar{R}^2$	h	$\bar{R}^2$	h	$\bar{R}^2$	h
Bath	0.87	0.70	0.84	1.94	0.91	2.59†
Birmingham	0.94	1.63	0.95	2.31†	0.89	1.48
Bristol	0.82	−0.80	0.81	−5.26†	0.83	0.54
Cardiff	0.90	3.21†	0.95	0.56	0.78	2.33†
Carlisle	0.63	3.29*	0.87	0.03	0.61	n/a
Edinburgh	0.83	−0.52	0.78	−0.33	0.86	−0.64
Glasgow	0.87	−1.91	0.84	1.25	0.86	−2.61†
Leeds	0.94	1.77	0.93	1.04	0.92	2.06*
Leicester	0.86	0.93	0.93	1.54	0.86	1.36
Liverpool	0.93	−0.34	0.94	−2.92†	0.95	0.17
Manchester	0.88	1.93	0.90	1.28	0.94	1.62
Newcastle	0.89	−1.08	0.89	0.86	0.87	−0.54
Norwich	0.86	0.50	0.86	0.65	0.86	0.36
Nottingham	0.82	−1.46	0.88	−0.70	0.80	−0.03
Plymouth	0.83	1.83	0.93	0.69	0.86	0.86
Preston	0.85	0.34	0.87	−1.33	0.90	−2.50†
Stockport	0.92	6.19*	0.88	0.50	0.94	5.32§
Swansea	0.81	1.34	0.94	−1.82	0.79	1.21
Swindon	0.80	1.18	0.89	−2.17†	0.78	1.45
York	0.88	2.22†	0.84	n/a	0.89	2.29†

n/a = h test not available.

* $|\hat{\rho}| < 0.10$
† $0.10 < |\hat{\rho}| < 0.20$
§ $\hat{\rho} = 0.21$

Wherever one of these three signs appears, the h test rejects the hypothesis of non-autocorrelated residuals at the 5 per cent level of significance.

Own fare elasticities

Table 2 gives estimated own fare elasticities for the flows between London and twenty provincial centres.

The fare elasticities (both short-term and long-term) are in general accord with *a priori* beliefs. The estimated elasticities are negative, flows with similar

TABLE 2

Short and Long Term Fare Elasticities:
London-Based Flows to Provincial Centres

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*	*s.t.*	*l.t.*
Bath	−0.54	−0.68	−0.42	−0.48	−0.77	−0.92
Birmingham	−0.69	−0.88	−0.66	−0.69	−0.80	−1.05
Bristol	−0.68	−0.93	−0.40	−0.49	−0.88	−1.21
Cardiff	−0.78	−0.91	−0.63	−0.69	−0.67	−0.76
Carlisle	−0.96	−1.20	−1.58	−2.10	−0.89	−1.06
Edinburgh	−0.53	−1.03	−0.28	−0.54	−0.83	−1.43
Glasgow	−0.58	−1.38	+0.41*	+0.73*	−0.78	−1.77
Leeds	−0.81	−1.21	−1.05	−1.46	−1.06	−1.68
Leicester	−0.72	−1.23	−0.89	−1.18	−0.78	−1.23
Liverpool	−0.92	−1.16	−0.98	−1.43	−1.04	−1.35
Manchester	−0.82	−1.12	−0.92	−1.11	−0.96	−1.28
Newcastle	−0.68	−0.80	−0.83	−0.95	−0.76	−0.99
Norwich	−0.85	−1.08	−0.67	−0.97	−0.90	−1.13
Nottingham	−0.68	−1.13	−0.15*	−0.18*	−0.95	−1.48
Plymouth	−0.72	−0.97	−0.45	−0.63	−0.86	−1.15
Preston	−0.47	−1.06	−1.03	−1.51	−0.78	−1.05
Stockport	−0.68	−1.08	−0.91	−1.30	−0.77	−1.20
Swansea	−0.87	−1.24	−0.67	−1.03	−0.92	−1.33
Swindon	−0.40	−0.61	−0.46	−0.72	−0.49	−0.74
York	−0.67	−0.82	−1.36	−1.36	−0.81	−1.03
Median	−0.69	−1.08	−0.67	−1.00	−0.81	−1.17

* Not significantly different from zero at the 5% level.

geographical and rail service characteristics (for example, Bath and Bristol, Cardiff and Swansea, Liverpool and Manchester) have elasticities of similar magnitudes, and the long-term median fare elasticity for total journeys is close to minus unity.

When journeys are disaggregated into first and second class, the estimated second class own fare elasticity is generally slightly higher than the first class own fare elasticity. However, this does not apply to Carlisle, Preston and York, where the estimated first class fare elasticities are considerably higher than their second class counterparts. Over all flows, the summary average (the median) indicates that the long-term second class fare elasticity is 17 per cent higher than the corresponding figure for first class fares. However, it should be noted that the average elasticities have been calculated over a relatively small number of flows, and are not weighted according to the traffic on each flow. In addition while the short term reflects instantaneous change (that is, the response of demand to a change in an explanatory variable that occurs within the 4-weekly data collection period), the long term will vary in length over the different flows.

Overall, the degree of precision in the estimation of the fare elasticities discussed above is quite high, and in only two equations out of sixty (the first class equations for Glasgow and Nottingham) are insignificant coefficient estimates obtained for the own fare variable.

Gross Domestic Product

The estimated elasticities of journey demand with respect to GDP are given in Table 3 for the London-based flows to provincial centres. The short and long-term median GDP elasticities for total journeys are 0.93 and 1.39 respectively; these are in general accord with our *a priori* beliefs, but there is a considerable degree of dispersion around these summary figures. Short-term estimated GDP elasticities range from (a statistically insignificant) 0.03 for York up to 1.82 for Newcastle, with comparable long-term estimates of 0.04 for York and 2.31 for Newcastle. In addition, nine of the twenty pairs of estimates were not significantly different from zero. It is interesting to note, however, that similarly geographically located flows still retain broadly similar elasticities (for example, Bath and Bristol, Liverpool and Manchester, Leicester and Nottingham).

For journeys disaggregated by class of travel, the median GDP elasticities are very similar to each other for both short and long-term effects. Again, dispersion around this median figure is very large. Norwich has the largest long-term elasticity for first class journeys with 3.29, while Carlisle has a long-term elasticity of 2.76 for second class journeys. At the other extreme, Swindon has comparable elasticities of 0.20 and 0.33 (both statistically insignificant). The geographical similarities that were noticed for total journeys are no longer so evident in these disaggregated equations.

One possible explanation for the large degree of dispersion around the median of the elasticities given in Table 3 could be that quarterly GDP statistics are only gathered for the nation as a whole. Quarterly regional estimates of GDP are not made in the UK, though quarterly data for unemployment, a variable that may proxy regional GDP with varying degrees of success, are gathered on a regional basis. As was stated earlier, however, over the period of this study there appear to have been substantial underlying changes in the operation of the labour market, and the use of unemployment to reflect local levels of economic activity could be extremely misleading. Estimates of regional GDP are published on an annual basis, but they are of little use to this study. The use of a national measure of GDP will clearly not reflect regional differences very well, and this may give rise to problems when we are considering flows which are atypical of the nation as a whole. Examples of atypical areas would be "depressed" areas such as Glasgow, Tyneside, and Merseyside at one extreme, and the relatively more affluent cities of southern England at the other.

TABLE 3

Short and Long Term GDP Elasticities
London-Based Flows to Provincial Cities

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*	*s.t.*	*l.t.*
Bath	1.10	1.38	1.45	1.67	1.68	2.00
Birmingham	1.14	1.43	1.47	1.47	1.28	1.68
Bristol	1.19	1.62	1.36	1.68	1.13	1.55
Cardiff	0.59*	0.69*	0.51*	0.51*	0.89	1.14
Carlisle	1.78	2.19	1.24	1.65	2.32	2.76
Edinburgh	0.48*	0.92*	0.14*	0.27*	0.94*	1.62*
Glasgow	0.61*	1.45*	1.14*	2.11*	0.17*	0.39*
Leeds	0.94	1.40	0.89	1.24	1.04	1.65
Leicester	1.18	2.02	1.13	1.51	1.24	1.97
Liverpool	0.92	1.16	1.17	1.72	0.84	1.09
Manchester	1.09	1.49	2.20	2.64	1.08	1.44
Newcastle	1.82	2.31	0.10*	0.11*	2.02	2.62
Norwich	1.49	1.89	2.27	3.29	1.31	1.64
Nottingham	0.94	1.57	2.00	2.44	1.25	1.95
Plymouth	0.74*	1.01*	1.13	1.60	0.80	1.06
Preston	0.21*	0.48*	1.35	1.99	0.78*	1.05*
Stockport	0.45*	0.63*	1.62	2.32	0.34	0.53
Swansea	0.59*	0.84*	0.65*	0.94*	0.78*	1.22
Swindon	0.24*	0.38*	0.13*	0.20*	0.22*	0.33*
York	0.03*	0.04*	0.99	0.99	–0.11*	–0.14*
Median	0.93	1.39	1.16	1.63	0.99	1.50

* Coefficient not significantly different from zero at a 5 per cent level of significance.

Trend

The estimated coefficients for the linear time trend term are given in Table 4. The interpretation of the coefficients for this time trend in terms of proportionate changes in rail demand involves a minor adjustment in their magnitude. To all intents and purposes, however, the estimated coefficients given in the tables are equivalent to estimated porportionate rates of change in journeys. These values represent the impact of the trend over a single data period (four weeks), so the annual proportionate rate of change in journeys explained by this trend can be obtained by compounding each figure over thirteen periods.

The median trend value implies an annual average long-term rate of decline in

TABLE 4

Short and Long Term Linear Time Trend Coefficients London-Based Flows to Provincial Centres

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*	*s.t.*	*l.t.*
Bath	−0.0020	−0.0025	−0.0071	−0.0081	−0.0011*	−0.0013*
Birmingham	−0.0033	−0.0042	−0.0061	−0.0061	−0.0027	−0.0036
Bristol	−0.0019	−0.0026	−0.0052	−0.0064	−0.0010*	−0.0014*
Cardiff	−0.0022	−0.0026	−0.0059	−0.0059	−0.0012*	−0.0015*
Carlisle	−0.0011*	−0.0014*	−0.0026	−0.0035	−0.0013*	−0.0015*
Edinburgh	−0.0011*	−0.0021*	−0.0023*	−0.0045*	−0.0013*	−0.0022*
Glasgow	−0.0001*	−0.0001*	−0.0020*	−0.0040*	−0.0003*	−0.0006*
Leeds	−0.0023	−0.0034	−0.0038	−0.0053	−0.0022	−0.0035
Leicester	−0.0020	−0.0030	−0.0042	−0.0056	−0.0017	−0.0027
Liverpool	−0.0038	−0.0035	−0.0053	−0.0089	−0.0015	−0.0019
Manchester	−0.0024	−0.0033	−0.0061	−0.0073	−0.0013	−0.0017
Newcastle	−0.0018	−0.0023	−0.0042	−0.0048	−0.0025	−0.0032
Norwich	−0.0022	−0.0028	−0.0053	−0.0077	+0.0015	+0.0019
Nottingham	−0.0018	−0.0030	−0.0057	−0.0070	−0.0016	−0.0025
Plymouth	−0.0003*	−0.0004*	−0.0042	−0.0060	+0.0003*	+0.0004*
Preston	−0.0001*	−0.0002*	−0.0007*	−0.0010*	+0.0007*	+0.0009*
Stockport	+0.0003*	+0.0005*	−0.0025	−0.0035	+0.0010	+0.0014
Swansea	−0.0025	−0.0036	−0.0052	−0.0081	−0.0027	−0.0025
Swindon	−0.0007*	−0.0011*	−0.0014*	−0.0021*	−0.0007*	−0.0011*
York	+0.0007*	+0.0009*	−0.0018	−0.0018	+0.0009*	+0.0011*
Median	−0.0020	−0.0026	−0.0042	−0.0058	−0.0013	−0.0015

* Coefficient not significantly different from zero at a 5 per cent level of significance.

total journeys of about 3.4 per cent. The corresponding estimates for first and second class journeys are for reductions of 7.8 per cent and 2.0 per cent, respectively.

For second class journeys, five of the estimated coefficients indicate that the long-term trend is one of growth, but only for the Norwich flow is such an estimate statistically significant. Indeed, the estimates for second class journeys are not, in general, well determined, as only eight are statistically significant at the 5 per cent level. The corresponding figures for total and first class journeys are 12 and 16 respectively.

The estimated secular decline in first class journeys is particularly high for a number of routes. It is over 10 per cent per annum for Bath, Liverpool, Norwich and Swansea, while Manchester is only marginally below the 10 per cent level.

As noted in section 2, the time trend captures the influence of several unmeasured factors, including the growth in car usage and local population growth/decline, but the growth in car usage is of particular importance. When GDP increases as a result of an increase in economic activity, it is likely to be associated with an increase in both business and leisure travel. At the same time, when incomes increase there is a tendency towards more car ownership, so that the net effect of an increase in GDP is difficult to determine. Button *et al.* (1982) note that as GDP falls there is a tendency for car ownership to continue to rise, at least in the short run, and it seems likely that during periods of slow growth in GDP, as in the period covered in this study, the increase in car ownership will tend to more than offset an increase in train travel. On the other hand, during periods of faster growth in GDP there might be an increase in all types of travel, so that the negative trend would be much less apparent.

Since the estimated GDP elasticities presented in the previous section were based upon a GDP series which was not detrended, the precise impact on rail passenger travel of increases in GDP alone can be calculated by subtracting the impact on rail journeys of these trend values from the increase in rail journeys generated by the GDP term. Since real growth in GDP over the sample period averaged almost exactly one per cent per annum, in general the elasticity of the trend term swamped that of GDP.

However, as pointed out in section 1, there was concern that for a number of reasons the proportion of journeys made recorded in the data base could have declined progressively over the period of the study. In that case the negative time trends would be overstated, giving an exaggerated view of the extent to which the negative impact on rail use resulting from increased competition from cars has offset the positive impact of GDP growth. In respect of one of the factors noted in section 1 – the reliability of the machines which record ticket sales at the point of purchase – there is indeed evidence of a progressive deterioration.

It was possible to carry out a broad assessment of the extent of the overall problem by grouping the flows examined in the study into their respective sub-sectors and analysing their proportionate contributions to total sub-sector revenue for the period 1976 to 1983. If we assume the relative constancy of demographic factors within the sub-sectors, a declining proportionate contribution to total sub-sector revenue on the part of the groups of flows would suggest a declining level of capture of data. In fact, there was evidence of this, and the result of the exercise suggested that the negative impact of unmeasured factors such as growth in car usage could well be less than the 3.4 per cent median trend value estimated in this study; an estimate in the range 2.0 to 2.5 per cent is probably more realistic. When this is combined with a median trend GDP elasticity of roughly 1.4 and a long-term GDP annual growth trend of, say, 1.5 to 2.0 per cent (rather than the 1 per cent used in this study), the implications of the relationship between the GDP elasticity and the negative time trend are quite different.

Competition

The impact of coach competititon on rail travel was investigated by introducing a dummy variable taking the value zero before deregulation of the coach industry in October 1980, and unity thereafter. An additional dummy variable was introduced into the relevant equations to reflect increased capacity and patronage of coaches after the introduction of the Rapide service. Only Cardiff and Swansea, however, showed a significant coefficient for this additional variable. In addition, the full impact of deregulation did not become evident on the NBC Newcastle to London coach service till the beginning of 1983, so the dummy variable accounting for this takes effect from then. The results for the London-based flows to provincial centres are given in Table 5.

With the exception of Stockport, the significant short and long term coefficients in Table 5 hover around –0.10 and –0.14 respectively. Neighbouring centres give remarkably similar results (for example, Liverpool and Manchester, Cardiff and Swansea). Shortly after the deregulation of the coach industry the London-Saver rail ticket was introduced on a trial basis on the Liverpool to London route and, a few months later, on the Manchester to London route. Since Stockport is situated in Greater Manchester, substantial savings could be made by second class passengers travelling from Stockport to London if they first travelled to Manchester and then purchased a Saver ticket to London. It is probable that the estimated coefficients for Stockport reported in Table 5 combine the effects of both coach deregulation and loss of London-bound rail traffic to the central Manchester station.

Competing air services were operational on three flows; a dummy variable was introduced to take account of this form of competition, taking the value of zero prior to 1982(8) and unity thereafter. The strikes that occurred on BR during 1982 necessarily caused a substantial fall in patronage on all flows. After the strikes, most flows increased their patronage to pre-strike levels. Edinburgh, Glasgow and Newcastle, however, were exceptions. A substantial number of passengers attracted to the shuttle air services during the strikes appear not to have returned to rail travel after the strikes had finished. In addition, competititon between the airlines increased dramatically, with services to both Gatwick and Heathrow. Fast access to central London was provided by BR from Gatwick and London Transport Underground from Heathrow. The results given in Table 5 suggest that air services from Glasgow were particularly successful in gaining additional patronage.

High Speed Train

The estimated proportionate change in journey demand with respect to changes in rail journey time and service brought about by the introduction of the HST are reported in Table 6. Overall, the introduction of the HST has ultimately led to an estimated (median) increase of 23 per cent in total passenger journeys; the increase is substantially higher (32 per cent) for first class than for second class (16 per cent) journeys. Both Bath and Swindon produce estimated effects substantially above the average.

TABLE 5

Short and Long Term Coefficients for Competition Dummy Variables: London-Based Flows to Provincial Centres

Centre	*Total Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*
(A) Coach Competition (after deregulation)				
Bath	−0.03*	−0.04*	−0.06*	−0.07*
Birmingham	−0.12	−0.15	−0.17	−0.22
Bristol	−0.01*	−0.01*	−0.07	−0.10
Cardiff	−0.07	−0.08	−0.10	−0.13
Carlisle	−0.06*	−0.08*	−0.06*	−0.07*
Edinburgh	−0.01*	−0.02*	−0.06*	−0.10*
Glasgow	−0.07*	−0.17*	−0.11*	−0.25*
Leeds	+0.01*	+0.02*	−0.02*	−0.03*
Leicester	−0.03*	−0.05*	−0.04*	−0.06*
Liverpool	−0.09	−0.11	−0.13	−0.17
Manchester	−0.11	−0.14	−0.16	−0.21
Newcastle	−0.05	−0.07	−0.05*	−0.06*
Norwich	+0.07*	+0.09*	−0.03	−0.03
Nottingham	−0.05*	−0.08*	−0.07	−0.11
Plymouth	−0.15	−0.21	−0.19	−0.25
Preston	−0.09*	−0.20*	−0.09	−0.12
Stockport	−0.15	−0.24	−0.19	−0.30
Swansea	−0.05	−0.08	−0.08	−0.12
Swindon	+0.02*	+0.03*	+0.01*	+0.01*
York	−0.08	−0.10	−0.09	−0.11
Median	−0.07	−0.08	−0.07	−0.11
(B) Coach Competition (Rapide service/or additional services)				
Cardiff	−0.07	−0.09	−0.12	−0.15
Newcastle	−0.27	−0.34	−0.25	−0.32
Swansea	−0.07	−0.11	−0.11	−0.16

(C) Air Competition

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*	*s.t.*	*l.t.*
Edinburgh	−0.14	−0.27	−0.06*	−0.12*	−0.20	−0.34
Glasgow	−0.16	−0.38	−0.29	−0.54	−0.17	−0.39
Newcastle	n.a.	n.a.	−0.19	−0.21	n.a.	n.a.

* Coefficient not significantly different from zero at a 5 per cent level of significance.
n.a. = Not applicable.

TABLE 6

Short and Long Term Effects of the High Speed Train London-Based Flows to Provincial Centres (where applicable)

Centre	*Total Journeys*		*1st Class Journeys*		*2nd Class Journeys*	
	s.t.	*l.t.*	*s.t.*	*l.t.*	*s.t.*	*l.t.*
Bath	0.40	0.54	0.70	0.84	0.35	0.43
Bristol	0.21	0.28	0.43	0.55	0.19	0.26
Cardiff	0.28	0.34	0.57	0.57	0.21	0.27
Edinburgh	0.07*	0.14*	0.16*	0.34*	0.07*	0.13*
Leeds	0.13	0.19	0.20	0.28	0.08	0.15
Leicester	0.03*	0.05*	0.22	0.30	0.03*	0.05*
Newcastle	0.06*	0.08*	0.38	0.45	0.08*	0.11*
Nottingham	0.14	0.23	0.13	0.13	0.02*	0.03*
Plymouth	0.01*	0.01*	−0.03*	−0.04*	−0.01*	−0.01*
Swansea	0.17	0.26	0.12	0.19	0.17	0.26
Swindon	0.26	0.42	0.63	1.12	0.19	0.30
York	0.19	0.23	0.22	0.22	0.13	0.17
Median	0.17	0.23	0.22	0.32	0.11	0.16

This table shows the proportionate change in journey demand resulting from the introduction of the High Speed Train.
* Coefficient not significantly different from zero at a 5 per cent level of significance.

Cross-fare elasticities

The first class cross-fare elasticity of demand measures the proportionate change in first class journeys resulting from variations in the level of second class fares. The second class cross-fare elasticity of demand may be defined in a similar manner. Estimated elasticities for both classes of travel were calculated in this study, but the majority were insignificant and a few appeared unreasonable.

Saver tickets

The stability of the fares variable was tested with reference to a possible change in the fares elasticity of demand upon the introduction of the London-Saver ticket during 1981. Since we are only interested in the change occurring in just one parameter, a simple dummy variable test can be used.

Consider the following simple two-variable regression model:

$$y_t = \alpha + \beta X_t + u_t \qquad t = 1, 2, \ldots, N.$$

Now assume that structural change occurs in period $T + 1$, so that the value of β is thought to change. We can rewrite this equation as

$$y_t = \alpha + (\beta + \Delta\beta)X_t + u_t \qquad t = 1, 2, \ldots, N$$

where $\Delta\beta = 0$ for $t \leqslant T$. By testing the significance of the estimated value of $\Delta\beta$ we are in fact testing whether the coefficient has experienced structural change. In essence, this reduces to creating a "new" dummy variable X_t^*, where

$$X_t^* = 0 \qquad t \leqslant T$$

and

$$X_t^* = X_t \qquad t \geqslant T + 1$$

and testing whether its coefficient, $\Delta\beta$, differs significantly from zero.

The results of this test were in general inconclusive, and the few significant results indicated only a very small rise (in absolute value) for the fares elasticity. It should be emphasised, however, that the test was for significant changes in the elasticity. The fact that most of the values were insignificant and/or very small is no indication of the success or failure of the Saver tickets in increasing or decreasing revenue.

The London-Saver tickets were introduced at a time of intense competition in price and service from the newly deregulated coach services. Thus one could argue that the large fall in the cost of second class rail travel brought about by the Saver ticket simply offset large-scale fare reductions introduced by coach service operators in the previous year, and therefore no great changes in the fares elasticity could be expected. In addition, on a number of routes pre-booking was required for Saver tickets. There is therefore a danger that on these routes a substantial proportion of the tickets so booked went unrecorded, and this would affect the data on which the results are based.

Fare elasticities and the level of real fares

The hypothesis that all elasticities in our study are constant, irrespective of the level of their associated variable, is implicit in the double-log formulation of our model. It is possible, however, that, particularly in the case of fares, the elasticity of demand may in fact be proportional to the level of the relevant variable. To test this hypothesis, consider the following model:

$$\log y_t = \alpha + \beta \log x_t + \gamma x_t \qquad (4)$$

which relates the log of demand (y_t) to both the log and the level of price (x_t).

The hypothesis that the price elasticity is constant implies that

$$\beta \neq 0, \gamma = 0$$

which leads to

$$\log y_t = \alpha + \beta \log x_t, \qquad (5)$$

with the price elasticity given by

$$\frac{\partial \log y_t}{\partial \log x_t} = \beta \text{ (a constant)}.$$

However, the hypothesis that the price elasticity is proportional to price implies that

$$\beta = 0, \gamma \neq 0$$

which leads to

$$\log y_t = \alpha + \gamma x_t, \tag{6}$$

where

$$\frac{\partial \log y_t}{\partial \log x_t} = \gamma x_t\ ,$$

that is, the price elasticity is proportional to x_t.

Note that equations (5) and (6) are "nested" in equation (4); that is, equation (4) is said to be a "comprehensive" model incorporating equations (5) and (6). If equation (6) represents our model, the constant elasticity hypothesis, $\gamma = 0$, may be tested by testing the significance of $\hat{\gamma}$. Similarly, the hypothesis that elasticity is proportional to price is tested by testing the significance of $\hat{\beta}$. The inclusion of additional variables in equation (6) does not invalidate the test procedure, and the above approach was used to test the constant elasticity hypothesis for the "total journeys" equation on all twenty routes. In estimating the comprehensive model there is an obvious problem of potential multicollinearity because of the correlation between x_t and its logarithm. This problem became particularly severe when the comprehensive model was formed for first and second class journeys separately, since a cross-price variable was also included, and for that reason only the "total journeys" equations were tested.

The coefficient estimate of the log fare had the correct *a priori* sign (that is, negative) for nineteen of the twenty flows, twelve of which were significantly different from zero, while the coefficient estimate of the fare level only produced three *a priori* correct signs. The test results, therefore, strongly favoured the hypothesis of constant elasticity.

Testing for Parameter Constancy

This test of the hypothesis of constant fare elasticity against proportional to real fare level was supplemented by a test for parameter constancy, based on fitting the specified regression model over non-overlapping time segments. The data were ordered according to the values taken by the fare variable and then divided into three equal segments of 49 observations. Further sub-division of the sample was not possible because of a lack of degrees of freedom.

Moving regressions were calculated over the three segments, and a test for parameter constancy based on the F statistic was carried out for all twenty flows.[3] In no case was the null hypothesis of parameter constancy rejected at the 5 per cent level of significance.

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[3] This and other tests for parameter constancy in regression analysis are described by Brown *et al.* (1975).

5. MAIN RESULTS AND CONCLUSIONS

This study has examined the effects on rail demand of a number of economic factors and has assessed their relative importance, using time series data and the tools of econometrics.

Unlike previous studies into the determinants of rail passenger demand, this study distinguishes between short and long term responses to changing economic conditions. When monthly data are used, this removes the somewhat unreasonable assumption that all change occurs instantaneously (that is, within the four-week data period). The distinction is of less importance if annual data are used.

Jones and Nichols (1983) obtained estimated elasticities which were, in general, lower than the short-term fares elasticities reported in this study, and considerably below the long-term elasticities. Their median fares elasticity was -0.67, compared with our short- and long-term estimates of -0.69 and -1.08. Fowkes *et al.* (1985) derived a fares elasticity of -0.86, which falls midway between the two elasticities reported here.

Direct comparison of other estimated elasticities with the results obtained by Jones and Nichols is not possible. Their study produced very few significant GDP elasticity estimates, and their other variables differed in construction from those specified for the model investigated in this study.

The quality of the data base used for this analysis was discussed in section 1. If the proportion of recording errors for ticket sales on each flow remained approximately constant over the sample period, then our log-linear specification of the demand model would ensure that the error of estimation was isolated in the estimated coefficient of the constant term, and that the estimated elasticities would remain consistent estimates of the true, unknown elasticities. If, however, recording errors varied over the sample period, then this would in turn have a deleterious effect on the estimated elasticities, the extent of which cannot be gauged without further information on the exact nature of the errors.[4]

For the twenty flows to provincial centres, total journeys were disaggregated to allow quantification of the determinants of both first and second class travel. Summary results, in the form of estimated elasticities (or proportionate changes in journey demand when dummy variables are involved), are shown in Table 7.

The estimated fares elasticities indicate that, in the short term, there is potential for improving revenue by increasing real prices, but that that policy is likely to prove unsuccessful in the long term as consumers vary their requirements in response to the new price level. Since the long term is almost invariably shorter than six months, and sometimes considerably shorter, any short-term gains are likely to be eroded fairly rapidly.

It is clear that over the sample period 1973 to 1984 British Rail has suffered severely from the state of the economy. The two major OPEC oil price shocks of 1973 and 1979 drastically reduced growth rates for Western industrialised nations as they attempted to restructure their domestic economies to accommodate severe increases in the cost of one of their most basic raw materials. By year-end 1976, GDP (in constant prices) for the UK had only just recovered

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[4] The more detailed version of this paper considers this problem in greater depth.

TABLE 7

Estimated Elasticities

Variable	*Short-term Elasticities*			*Long-term Elasticities*		
	Total Journeys	*First Class*	*Second Class*	*Total Journeys*	*First Class*	*Second Class*
Fares	−0.69	−0.67	−0.81	−1.08	−1.00	−1.17
GDP	0.93	1.16	0.99	1.39	1.63	1.50
Trend (% per year)	−2.6	−5.6	−1.7	−3.4	−7.6	−2.0
Coach competition	−0.07	n.a.	−0.07	−0.08	n.a.	−0.10
HST*	0.17	0.22	0.11	0.23	0.32	0.16

* Where applicable.
n.a. = Not applicable.

to its 1973 level. Over the entire sample period, GDP only rose by a little over 11 per cent (that is, it rose by almost exactly one per cent, on average, per annum). Thus, though the estimated long-term average (that is, median) elasticities with respect to GDP are around 1.5, the actual long-term growth in GDP was too small to have any great impact on passenger rail journeys. In addition, it is apparent from the regional rates of unemployment that variations in GDP had a greater impact in some areas than in others.

When we turn to the long-term negative time trend estimates obtained in this study – 2.0 per cent for second class fares and 7.8 per cent for first class fares – it appears that the effects on rail passenger demand of overall changes in GDP over the sample period were swamped by this downward trend, particularly for first class travel. However, as explained in section 4, a declining level of data capture will lead to a considerable overstatement of the extent to which this occurred. Indeed, if we modify our estimates of the time trends to take account of this, and consider the likelihood of rates in the range 1.5 to 2.5 per cent after the period of oil shocks, we find that the influence of the external environment on rail passenger demand is broadly neutral, and factors such as fares, quality of service and competition are more important.

Two significant factors that, at various times and to different degrees, have had an impact on rail passenger demand are changes in the level of competition and improvements in the quality of British Rail services brought about by the introduction on a number of routes of the High Speed Train.

The effect on rail passenger demand of the deregulation of the coach industry in October 1980 varied greatly from route to route. Overall its impact appears to have been relatively small, but this is no doubt a result of the more aggressive pricing policy adopted by British Rail in 1981 in the form of the London-Saver. The fact that both these events occurred within a period of a few months is not conducive to precise estimation of their individual impact on demand, since their opposing influences will be compounded in the data.

It appears that the industrial unrest in British Rail in 1982, which led to major strike action, caused a substantial loss in first class passenger journeys on the two Scottish flows (Edinburgh and Glasgow) and, to a lesser extent, to Newcastle. The fact that this loss was not subsequently recouped suggests an increase in the effectiveness of airline competition on these three routes.

Overall, the introduction of the HST led to substantial improvements in patronage, especially for first class journeys, which, for a time at least, offset the secular decline that was evident over the period. As no similar dramatic improvements are in prospect for the immediate future, the exogenous decline in passenger traffic can only be countered by an offsetting growth in GDP.

The difficulty of estimating the cross-fares elasticity of demand has been explained. Where reasonably precise estimates were possible, the impact of increases in first class fares on second class travel was very marked.

Overall, the results from these twenty London-based flows to provincial centres are particularly encouraging from the point of both internal and external consistency. In view of the obvious limitations inherent in the data, and the amount of background noise, the results achieved exhibit a remarkably high degree of consistency and precision.

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