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# **Competition and the Provision of Rail Passenger Services: a simulation exercise**

Daniel Johnson<sup>1</sup> and Chris Nash<sup>2</sup>

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## **ABSTRACT**

This paper presents the results of simulating the effects of introducing competition on a long distance international rail passenger route where there is also a strong domestic market served by high speed trains. We are aware of a number of proposals to introduce new services in such circumstances. It has allowed for the fact that on such a service seat reservations are likely to be compulsory and yield management practiced, so that whatever is initially assumed about fares there will be further endogenous changes in average fares to maintain high load factors. It is found that on-track competition has benefits to consumers, in terms of fares and services, but that it would reduce the profitability of the incumbent and that it would be difficult for the new entrant to attain profitability unless its costs were significantly lower than those of the incumbent. A large part of the revenue of the entrant on this route would come from the domestic market, and if open access competition were permitted then the entrant might seek to run a frequent service offering head on competition on this part of the route. However, again it would appear that both operators would make heavy losses in this situation. One way of restoring profitability might be to reduce track access charges, but that would require additional government subsidy to the infrastructure manager, as the additional train kilometres run would not compensate for the lower charges. An alternative way of seeking to achieve the same result as on track competition in terms of reduced costs

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<sup>1</sup> Institute for Transport Studies, University of Leeds, LS2 9JT, 0113 3436607

<sup>2</sup> Institute for Transport Studies, University of Leeds, LS2 9JT, 0113 3435337

and innovation whilst preserving economies of density would be to award a monopoly franchise by means of competitive tendering. Franchising has generally succeeded in raising rail demand and reducing costs, although in the one example where inter-city services were franchised – Britain – costs have actually risen. Thus unless this is due to peculiarities of the British situation which would not exist elsewhere, on track competition may still have a role in reducing costs.

Keywords: Rail Passenger Services, Competition, Franchising

**24<sup>th</sup> August 2012**

## **1. INTRODUCTION**

The policy of the European Commission is to introduce competition within the rail sector, and this has already been implemented for freight services. In the case of passenger services, as from January 2010 open access has been required for cross border services, including the right for them to carry domestic passengers, provided that the primary purpose of the service is to carry international passengers, and it does not disturb the financial equilibrium of a service subject to a public service contract. Although there is currently no requirement to open up the domestic passenger market to competition, the European Commission is considering proposals for this (1), and a number of countries have already done so, by means of two alternative mechanisms. Firstly in a number of countries new entrants are legally permitted in the commercial market to compete directly with existing operators, although some barriers to entry have remained. Until recently actual levels of entry to date have been low, and mainly confined to niche markets, but in the last year new entrants have introduced frequent services operating in head on competition with the incumbent between Vienna and Salzburg, and on the new Italian high speed line between Milan and Naples. There are a number of other cases where major operators such as the state owned railways of Germany and Italy are known to be interested in entering the international market. Secondly, in Britain, Sweden, Germany, and to a lesser extent in a number of other countries, competitive tendering takes place for the franchises to operate some or all services. Britain is unique in that this tendering extends to virtually all commercial services, which pay a premium, as well as subsidised services, although the Netherlands also used competitive tendering for operation of its new high speed line.

The aim of this paper is to contribute to the understanding of the likely consequences of new entry into the commercial passenger market both on international and domestic routes. To do this we have applied the PRAISE software tool to both an international route and the domestic portion of that route. PRAISE was developed by our Institute to estimate the revenue, costs and benefits of different levels of services and fares provided by competing companies, allowing for the exact choice of train made by the user and

incorporating a feedback whereby the level of crowding in each individual train influenced the choices of the passengers. For the purposes of this study, we enhanced the PRAISE model to allow for compulsory seat reservations and to incorporate a yield management system, which dynamically adjusts fares in line with remaining available seating capacity. To our knowledge this is the first disaggregate rail forecasting model to incorporate this facility, which is of great importance in analysing high speed rail services.

In Section 2, we review the literature on passenger market competition, both via competitive tendering and open access. In Section 3 we present the enhanced PRAISE model, and we outline the results of the new modelling exercise in Section 4. Finally, we reach our conclusions in Section 5.

## **2. COMPETITION IN RAIL PASSENGER MARKETS.**

As noted in the introduction, there are two forms of competition to be found in rail passenger markets in Europe. The most common one is competition via competitive tendering for the contract to run a specific set of services. This is generally the only form of competition possible for the large proportion of the rail passenger network which requires subsidy. One would expect that, since only a cost efficient company can expect to win a tender, competitive tendering would drive down costs to an efficient level. Whether it will lead to enhanced services may be expected to depend on the nature of the contract; if services and fares are completely specified by the tendering authority under a gross cost contract, then whether services improve will depend entirely on their decision (but it may be that cost reductions will free the resources to allow such improvement). By contrast, a net cost contract, in which the operator bears revenue risk but has at least some freedom regarding services and fares, will give incentives to attract more revenue, particularly on more commercial services where revenue is reasonably high compared with costs. In practice, the evidence is that services have improved (2, 3) and costs been reduced (4) in all countries which have practiced competitive tendering with one exception, In Britain, the one country which has introduced competitive tendering for all services, commercial and subsidised, train operating costs have actually increased significantly such franchising was introduced (5).

The reasons for this failure for franchising to reduce costs in Britain appear complex (5), associated with a number of factors including the market power given to the unions by the fragmentation of the rail system, with no single dominant operator, the willingness in the past of the British government to renegotiate where franchises proved unprofitable and the general disruption to the rail sector caused by the events associated with the bankruptcy of the infrastructure manager, Railtrack. Of particular interest in the current context however is the difference from the labour market situation in other countries which practice competitive tendering. In Britain the incumbent, British Rail, was not allowed to bid for franchises and ceased to exist as a train operator, but in order to ensure a smooth transition, whoever won the franchise was obliged to take on existing staff at current wages and conditions. This has encouraged franchisees to compete in terms of wages and conditions for scarce skilled labour, knowing that when the franchise is relet their competitors will face the same wages and conditions as they do. In both Germany and Sweden, the state owned operator is allowed to bid, remains a major operator and often retains its own staff even when it loses a franchise. Competitors are free to recruit their own labour and to set their own wages and conditions. As a result the threat of competition from lower cost companies serves to restrain the power of the unions more in these countries than in Britain. Perhaps the British approach is inevitable where all services are franchised, as the transition problems of new companies needing to recruit staff on the necessary scale would otherwise be formidable.

With open access competition, this issue does not arise and a new entrant will certainly be able to determine its own working practices, wages and conditions. One might therefore expect a new entrant to have lower costs, and in turn to put pressure on the costs of the incumbent. As against this, there is strong evidence of economies of density in train operating companies (6), which a small entrant will be unable to exploit (but as noted above, new entry is not always on a small scale). If new entry simply reduces load factors then their unit costs will rise. But of course this may be countered by fares reductions by both entrant and incumbent. The question then is to what extent this fares reduction will reduce profitability and whether it is sustainable.

At the same time, new entry may improve services, both simply by providing a wider choice of departure times and by incentivising improvements in comfort and on board service. As against this, if tickets are not interchangeable, then for passengers who desire flexibility in departure times frequency will not improve, and if the incumbent is forced to cut services it may actually deteriorate. Moreover, there is evidence that a planned integrated timetable with good connections gives benefits which may be lost if the timetable is determined by competing operators (7) .

At the time of writing there is very limited experience of open access competition in passenger markets. In Germany, open access for new entrants who wish to operate commercial services has been authorized by law since 1994, but there has only been a very limited amount of new entry, and what has taken place has been in niche markets; usually routes not otherwise served by through train services, but also sometimes involving special services such as sleeping cars. Mostly, these services have been provided by existing operators of regional services, who can thus share staff and rolling stock between commercial and subsidised services (8). There are a number of reasons identified in the literature for the low level of entry, including the low profitability of many routes, relatively high infrastructure charges, the advantages of an integrated passenger network, and lack of capacity on key routes and at the busiest times of day. There have also been allegations of continued barriers to entry. In Germany, the main operator and the infrastructure manager remain part of the same group, which is also the main provider of services such as maintenance, cleaning and information, and it is alleged that this position has been used to try to prevent entry.

In Britain, new entry is only permitted if the Regulator is satisfied that it will attract new traffic to the rail network rather than mainly divert traffic from existing (franchised) services. (9) The small number of services now running all provide through services to London from places not otherwise so served (or only served once per day in the case of Hull) but do compete directly with frequent franchised services between some places on the main line. Although open access services have been started by small companies, all those now running are provided by big groups (namely DB and First) who also provide

franchised services, and most of the interest in further open access operation is coming from one of these groups (DB, through its subsidiary Arriva). Studies (3) have shown that the existing open access operations offer lower fares and benefits to users, but it has been argued that by running shorter trains they are not optimising the use of scarce track capacity (they only pay track access charges based on short run marginal cost and which do not include a scarcity charge).

On-track competition has also occurred in Britain between different companies where services are franchised and franchises overlap (10). Indeed there has been much debate as to whether franchises should be deliberately designed to promote this type of competition between major cities. Typically this again has been competition between an inter-city operator and a regional or commuter operator, with the latter offering slower, less comfortable services at lower fares. Key routes where this has happened are London to Birmingham, Peterborough, Cambridge and Ipswich. To the extent that such competition makes use of spare capacity in the lower cost operator to relieve long distance operators of medium distance traffic it may be particularly beneficial.

Although there is now a considerable literature seeking to analyse the impact of rail reform on costs by means of econometric studies using panel data for a number of countries with different degrees of reform over time, little of it deals explicitly with passenger market competition, given how limited this is. In many cases, as with (11), the variable representing market entry concerns freight rather than passenger. Asmild et al (12) find that competitive tendering in the passenger market reduces materials costs but not staff. However, their data only goes up to 2001. In the most recent study to identify these separately, Cantos et al (13) find separate beneficial effects of vertical separation and introduction of competition in the freight market, whereas passenger franchising has no such effect. However, of the four countries in their sample in which passenger franchising has been introduced only in Sweden and Germany has it covered a significant proportion of regional services and in none has it covered commercial services. None of these studies considers open access passenger competition given its very limited extent.

The only equivalent demand side study of which we are aware is (14), who estimate a regression

model relating mode split to various explanatory variables, including rail industry structure and market opening as well as measures of public spending on rail, strength of regulation and GDP per capita. In the passenger sector, both vertical integration and liberalisation have a strong positive impact on rail mode split, whilst public spending on rail has none. However, again actual passenger market competition is overwhelmingly competitive tendering rather than on-track competition. As noted in the introduction, more experience of on track competition is now taking place, although it is too recent yet to have been analysed in the literature. Thus other studies of on track competition have taken the form of modelling exercises. There have been several attempts to model competition in the rail passenger market using the PRAISE software. PRAISE (Privatised Rail Services) is a model designed to simulate the effect of competition between operators. It predicts the impact of changes in fares and services on the overall volume of rail travel and on its share between operators, by simulating the decisions of a sample of individuals choosing between combinations of individual trains and ticket types, in the light of their preferences regarding departure time and values of time. Recent applications also include consideration of overcrowding on individual services (see, for example Whelan and Johnson, [15]). Subject to data availability, it also undertakes a cost-benefit analysis of the impact of the competition on operators, passengers and society at large.

The most relevant past studies in the current context are studies of open access competition on intercity lines in Britain and Sweden. Preston, Wardman and Whelan [16] first used PRAISE to address the issue of competition in the market through open access operations, based on a case study of a busy intercity route in Britain, with approximately 2 million end-to-end passenger journeys per annum, linking two major cities with substantial commuting at either end. They look at four possible scenarios for duopolistic on-track competition:

- Cream Skimming: Here it is assumed that the entrant is able to "cherry pick" peak services without the obligation to operate possible loss-making services in the off-peak.

- **Head-on Competition:** In this scenario it is assumed that the entrant matches the service frequency of the incumbent. Each operator is assumed to operate alternate trains throughout the day.
- **Price War:** A natural development to head-on competition and it is assumed the entrant is the price leader.
- **Service Quality:** Finally they examine quality competition by examining the prospects for a slower but cheaper service running on a parallel route.

They conclude that entry based on cream skimming and fare reductions may be profitable, but does not increase overall welfare, as the benefits to users do not offset the operating costs of the additional services. In practice, it is to be expected that such cream skimming might be forestalled by the incumbent who would provide its own additional services. In their case study they estimate that the incumbent can broadly double its service frequency and still break even on this particularly profitable route.

They find that head-on competition is not generally feasible except where the entrant is only charged for the marginal cost of infrastructure provision, but entry in this case results in a reduction of economic welfare for the reason stated above. By contrast competition from a lower quality cheaper service is feasible. In these circumstances, the entrant could capture a significant market niche, namely peak hour non-business travellers. With fares at 50% of those on the incumbent's franchise, the parallel entrant could capture 25% of the rail market.

The study did not consider costs in detail assuming entrant and incumbent have the same variable costs, and does not consider overcrowding. If competition drives down costs, by introducing a lower cost competitor, and thus also putting pressure on the costs of the incumbent, then the benefits are likely to be greater. However, in the British context it is assumed that any such cost reductions will already be produced by the need to compete for the franchise.

Similar work in Sweden by Preston, Holvad and Rajee [17] modelled the effect of competitive scenarios for two lines, one a high frequency inter-city service and one a low frequency inter-city service.

Two service options were examined – where an entrant matches the services of the incumbent (head-on competition) or only runs one train in each direction in peak periods (fringe competition). It was assumed the entrant matches the incumbent's fares or offers reductions across all ticket types. The incumbent maintains initial fares or matches the entrant's fare reductions. It is assumed tickets are not inter-available.

This work actually found that with lower track access charges, head-on competition was commercially feasible on the busiest routes although it might be capacity constrained. Such competition was not desirable as it led to excessive service levels. On less busy routes, welfare was maximised when there were substantial fare reductions and modest service reductions. Any scenarios involving profitable fringe competition on the less busy lines were in peak periods and reduced welfare.

Three key conclusions emerge from past simulation exercises. Firstly, the extent of competition attracted will be very dependent on the level of track access charges, which greatly influence the scope for profitable entry. Secondly, if there are no constraints on entry, the most likely form of entry is 'cream skimming'; i.e. simply duplicating the most profitable services of the existing operator, and reducing their profits. Only on the busiest routes is it likely that head-on competition - high frequency duplicate services by two or more operators - can survive. Thirdly, it is likely that competition will generally lead to excessive levels of service and costs, for which the benefits to consumers will be more than offset by the losses of profitability to the existing operator.

### **3. THE ENHANCED PRAISE MODEL.**

#### ***3.1 Introduction***

As part of this study, the PRAISE model was enhanced to model open access competition on a high speed international route to a major European capital city for a number of scenarios. The PRAISE model estimates the demand and revenue of each competitor for a postulated scenario in terms of the timetable they operate and the fares they choose, by means of a choice model as explained below. The choice model estimates the choice of train and ticket type and normally incorporates a feedback whereby the level of

crowding on the train influences the choice of train. However, since the types of service modelled in this case are normally subject to compulsory seat reservation and use of a yield management system, we modified PRAISE to take account of these features as discussed below. The result is that, whatever the initial assumption about fares, there is a degree of endogeneity, as mean fares adjust to achieve the target load factors set in the yield management system.

### 3.2 Choice Model

When making a rail journey, a passenger will often have a choice from a number of different services and ticket types. For example, they could choose to travel in the peak using an unrestricted ticket or in the off-peak using a less expensive restricted ticket. If we know when the passenger would ideally like to arrive we can estimate a generalised cost for each option (service and ticket combination) available and assign each a probability that it will be chosen:

The probability that an individual will choose a given service and ticket combination conditional that they chose rail is:

$$P_{n|r} = \frac{\exp(U_n)}{\sum_{n' \in N} \exp(U_{n'})} \quad (1)$$

where  $U_n$  is the utility of option  $n$ , which is given by:

$$U_n = -\lambda_t GC_n \quad (2)$$

where:

$GC$  is the Generalised Cost for option  $n$

$\lambda_t$  scales the model to replicate given GC elasticities

$U_{n'}$  is the utility of option  $n'$ .

We assume First Class and Standard Class are independent, segmented markets, analysed separately but aggregated in the final presentation of results. In practice, it might be that big changes in standard class fares would lead some passengers to switch from or to first class and vice versa, but we do not think this would be a major effect within the range of fares we explore in this paper.

### ***3.3 Sample Individuals***

The choice modelling hierarchy is typically repeated for a sample of 500 individuals drawn from known desired arrival time profiles specific to each OD pair.

As well as having individual specific desired arrival times, individuals were assigned randomly distributed values of time. These were chosen to retrieve the overall mean and standard deviation of the distribution as supplied to us, for both Standard and First Class. We introduced a correlation between the desired arrival time distribution and the values of time such that those individuals travelling in the peak had values of time which were on average 33% higher than those in the off-peak. Peak travellers were defined as the 66% of the sample who were travelling at the most popular times as given by the distribution.

### ***3.4 Ticket types***

For most OD pairs we were supplied with pricing information on two ticket types:

- ‘Type 1’: these tickets are on average cheaper but are fixed in number and price
- ‘Type 2’: these tickets are variable in price, rising as the available seating capacity on the train falls, as determined by the yield management system. We used a quota of ‘Type 1’ tickets to recover the known split between these ticket types.

### ***3.5 Model Calibration***

There are two stages to the calibration of the demand model. The first involves the estimation of the generalised cost of travel for each service and ticket combination. The second involves setting the ‘scales’ of the choice model so that it replicates known elasticities of demand. These calibration stages are set out in more detail below.

### ***3.6 Estimation of Generalised Cost***

For each simulated individual in each origin-destination pair on the network, the model estimates the generalised cost (GC) of travel for each available ticket type and, and assigns each travel option a probability that it will be chosen using multinomial choice model in equation 1.

For a given individual, the generalised cost of each rail option,  $n$ , is given as:

$$GC_n = F_n + (vot * GJT_n) \quad (3)$$

where:

$F$  is the fare

$GJT$  is the generalised journey time (minutes)

$vot$  is the individual's behavioural value of time (pence per minute)

The generalised journey time is expressed as:

$$GJT_n = IVT_n + \left( \frac{vat}{vot} * AT_n \right) + IP_n + (2 * OVT_n) \quad (4)$$

where:

$IVT$  is in-vehicle time (minutes)

$AT$  is schedule adjustment time (minutes). This is the difference between a passenger's most desired time of arrival and the actual timetabled arrival time.

$vat$  is the individual's behavioural value of schedule adjustment time (pence per minute)

$IP$  is an interchange penalty (minutes)

$OVT$  is out of vehicle time (minutes), ie wait time at interchanges

For calculation of generalised time, as with previous applications of the PRAISE model, we used the following assumptions:

- wait time at interchanges were weighted  $2*vot$  (value of in-vehicle time).
- adjustment time (how far service arrival time is from sampled individuals' desired arrival time) weighted at  $.66*vot$
- interchange penalty of 35 mins.

- 90 minutes access/egress time

The attributes included within the generalized journey time expression are for the most part well known and we have drawn from the wealth of literature providing evidence on relative attribute values (see for example, the Passenger Demand Forecasting Handbook [18]). Of course these attribute values are only appropriate for long distance services.

Demand modelling in this application of PRAISE requires the following information for each Origin Destination (OD) combination of a specific case study network:

- Service Patterns; ie timetable
- Base Demand Levels and market shares of different ticket types
- Fares and fare structures
- Desired Arrival Time profiles
- Behavioural values of time
- Fare and Journey Time elasticities

We were supplied with estimates of these by the client, but we cannot reproduce the detailed inputs and outputs of the model because of the conditions of commercial confidentiality under which the data was provided to us.

### ***3.7 Setting the Scale of the Model***

The demand model includes the scaling coefficient ( $\lambda$  value) which allows for the fact that changing fares and services will change the overall demand for rail. The model will allow rail's market share to expand or contract according to the overall quality of rail. This is calculated for each OD using an incremental logit applied to rail's mode share.

### **3.8 Calculating Revenues**

The market shares for the two ticket types are recovered by averaging the derived probabilities over all simulated individuals to give service loadings and demands. From this we can calculate revenues.

### **3.9 Yield Management System**

The incumbent operator employs a yield management system when pricing the 'Type 2' tickets. This is a dynamic pricing mechanism which increases in response to the number of tickets sold. Although the full details of the system were not available we were supplied distributions of ratios of fare/average fare over the different loading factors for different service types, average fares for each OD pair, and the seating capacities of the different services. This adds complexity to the modelling as we have to record the passenger loadings and thus loading factors at different points on the corridor in order to determine the available capacity upon which ticket pricing is based.

Whilst there are a number of stations on our network, we adopted a simplified approach to generating loading factors, based on the loadings between three key stations on the route, Stations *A* and *C* situated at either end, with Station *B* at some point between. There were a number of smaller stations on the network, but for simplicity we show just two smaller stations, *d* and *e* in the graphical example below in Figure 1 to illustrate our approach. Any flows not involving travel to or from at least one of these three key stations (here represented by *de*) were not included in our analysis as demands were extremely small and not provided to us.

Fares for travel between any ODs which used the section between stations *A* and *B* were based on the loadings of passengers whose journey involved travelling in full or partway between *A* and *B*. From our graphical representation, this would include *Ad*, *AB*, *AC* and *dB*, *de* and *Ae*. Because *AB* is the dominant flow for this part of the network, any passenger undertaking partway journey, ie *Ad* and *dB* would prevent the seating capacity being used for a journey from *A* to *B*.

Fares for travel between remaining ODs which included the section between stations  $B$  and  $C$ , ie  $dC$ ,  $Be$ ,  $BC$  and  $eC$ , were based on load factors calculated from passengers whose journey involved travelling in full or partway between  $B$  and  $C$ .

This process is undertaken in 500 steps, corresponding to each of the 500 sample individuals on each flow as in Section 3.2. The fares for the  $i$ th individual on a particular OD pair are based on the load factors resulting from the choices of the previous  $i-1$  individuals over all the flows. Note, these individuals are representative individuals for simulation purposes, and they each represent  $1/500^{\text{th}}$  of the total daily demand for that flow.

**Figure 1: Simplified Diagrammatic representation of the network.**



Whilst a scenario will clearly change the balance of market share between the incumbent and its competitor, it will also change the market share of rail and consequently overall rail demand. This change in demand will change loadings on services and have a second order effect on the yield management system. Thus, when considering the implementation of scenarios, the model is iterated ten times so that demand reaches a new steady state.

### **3.10 Implementation of Scenarios**

Following the estimation of the generalised cost of each option and the calibration of the scaling coefficients, the model is applied to generate forecasts for each operator and ticket type. Scenarios are specified in terms of changes to the timetable/service or fares. In this way new services and operators can be introduced, some with pricing competition, and results compared against the base.

We assume that the entrant will use a yield management system identical to that of the incumbent on this route, and PRAISE was adapted to model this system. It should be noted that, since the yield

management system leads to the sale of more low priced tickets when there are more empty seats, this does not mean that the final average fares charged will be the same for both operators; moreover, new entry which brings more capacity will tend to reduce average fares even where we do not explicitly take a decision to do so.

## **4 THE CASE STUDY**

### ***4.1 Introduction***

This case study is based on data on an actual route and thus the actual data itself is confidential. However, in order to compute costs, typical data for high speed trains has been taken from another source (19) and thus the final results must be regarded as typical for a route of these characteristics rather than applying to any particular route. We took data on typical track access charges for high speed trains from work by the International Transport Forum (20) and assumed a substantial mark up on marginal cost for the heavily used domestic part of the route, but charges close to marginal cost for the rest.

The route in question is a long distance international route, with low frequency services serving major cities linked by much faster air services. Thus it only attracts limited numbers of end to end passengers, mainly leisure passengers on relatively low fares. However, it also links domestic cities in one of the countries which form a major profitable rail market, with frequent rail services including much business travel at substantially higher fares. It may therefore attract entry into the international market under current legislation partly in order to attack the major domestic market. Were new entry permitted directly into the domestic market, then of course it would be expected that many if not all of the entrants trains would only serve the domestic market. There are in fact a number of similar routes within Europe where it is known that train operators are interested in entering the market.

We examine the following scenarios:

### *Scenario 1*

It was assumed the entrant would match the service of the incumbent by running an infrequent service over the entire international route. By means of a slightly different route and stopping pattern, these trains run end to end 15 minutes quicker than the existing services, and exercise the right of cabotage by stopping at the major domestic city, and competing for the high volume of passengers between this city and the capital.

### *Scenario 2*

This is as Scenario 1 but with a price cut of 10% on fares offered by the entrant. In reality it may be that an entrant would lower fares more, but a 10% cut will be enough to investigate the sensitivity of results to changes in fares. In any event, because of the way the yield management system works, if there remains spare capacity after a 10% fares cut, the actual cut will prove to be greater than this.

### *Scenario 3*

As Scenario 1 but with an initial price cut of 10% on fares offered by both entrant and incumbent

### *Scenario 4*

In this scenario we assume the entrant offers a domestic service similar to the existing one on this route, timed to run halfway between the services of the incumbent. It is recognised that this type of competition would not currently be permitted, and that in any case track capacity would probably be inadequate, but the scenario was introduced to examine an extreme case in terms of head on on-track competition. Initial fares were assumed unchanged, but the additional capacity meant that the yield management system worked to reduce average fares.

**Table 1: Indexed Results for Base and Scenarios**

			Base: No competition			Scenario 1: Niche Market Entry			Scenario 2: Niche Market Entry with 10% fares reduction			Scenario 3: Niche Market Entry with 10% fares reduction for Entrant and Incumbent			Scenario 4: Head on Competition		
			Dom	Int	Total	Dom	Int	Total	Dom	Int	Total	Dom	Int	Total	Dom	Int	Total
Demand	Index	Incumbent	0.93	0.07	<b>1.00</b>	0.90	0.06	<b>0.96</b>	0.90	0.06	<b>0.95</b>	0.97	0.06	<b>1.03</b>	0.68	0.07	<b>0.75</b>
		Entrant	-	-	-	0.07	0.03	<b>0.10</b>	0.08	0.04	<b>0.11</b>	0.07	0.04	<b>0.11</b>	0.62	0.00	<b>0.62</b>
	(base =1)	<b>Total</b>	<b>0.93</b>	<b>0.07</b>	<b>1.00</b>	<b>0.97</b>	<b>0.09</b>	<b>1.06</b>	<b>0.97</b>	<b>0.09</b>	<b>1.07</b>	<b>1.04</b>	<b>0.10</b>	<b>1.14</b>	<b>1.31</b>	<b>0.07</b>	<b>1.37</b>
	%Change	Incumbent	-	-	-	-3.7	-12.0	<b>-4.3</b>	-4.0	-12.5	<b>-4.6</b>	3.5	-5.9	<b>2.8</b>	-26.6	0.0	<b>-24.9</b>
		<b>Total</b>	-	-	-	<b>3.6</b>	<b>37.7</b>	<b>5.9</b>	<b>4.2</b>	<b>40.3</b>	<b>6.6</b>	<b>11.4</b>	<b>47.1</b>	<b>13.8</b>	<b>40.1</b>	<b>0.0</b>	<b>37.4</b>
Revenue	Index	Incumbent	0.92	0.08	<b>1.00</b>	0.87	0.07	<b>0.94</b>	0.87	0.07	<b>0.93</b>	0.87	0.07	<b>0.94</b>	0.56	0.08	<b>0.64</b>
		Entrant	-	-	-	0.06	0.03	<b>0.10</b>	0.07	0.03	<b>0.11</b>	0.07	0.03	<b>0.10</b>	0.51	0.00	<b>0.51</b>
	(base =1)	<b>Total</b>	<b>0.92</b>	<b>0.08</b>	<b>1.00</b>	<b>0.94</b>	<b>0.10</b>	<b>1.04</b>	<b>0.94</b>	<b>0.10</b>	<b>1.04</b>	<b>0.94</b>	<b>0.10</b>	<b>1.04</b>	<b>1.07</b>	<b>0.08</b>	<b>1.15</b>
	%Change	Incumbent	-	-	-	-5.4	-10.7	<b>-5.8</b>	-6.1	-12.5	<b>-6.6</b>	-5.4	-10.1	<b>-5.8</b>	-39.3	0.0	<b>-36.2</b>
		<b>Total</b>	-	-	-	<b>1.6</b>	<b>32.1</b>	<b>3.9</b>	<b>1.7</b>	<b>32.5</b>	<b>4.1</b>	<b>1.7</b>	<b>33.4</b>	<b>4.1</b>	<b>16.4</b>	<b>0.0</b>	<b>15.1</b>
Pass KMs	Index	Incumbent	0.88	0.12	<b>1.00</b>	0.85	0.11	<b>0.96</b>	0.85	0.11	<b>0.95</b>	0.91	0.11	<b>1.03</b>	0.65	0.12	<b>0.76</b>
		Entrant	-	-	-	0.07	0.05	<b>0.11</b>	0.07	0.05	<b>0.13</b>	0.07	0.05	<b>0.12</b>	0.59	0.00	<b>0.59</b>
	(base =1)	<b>Total</b>	<b>0.88</b>	<b>0.12</b>	<b>1.00</b>	<b>0.92</b>	<b>0.15</b>	<b>1.07</b>	<b>0.92</b>	<b>0.16</b>	<b>1.08</b>	<b>0.99</b>	<b>0.17</b>	<b>1.15</b>	<b>1.24</b>	<b>0.12</b>	<b>1.36</b>
	%Change	Incumbent	-	-	-	-3.8	-8.2	<b>-4.3</b>	-4.1	-8.7	<b>-4.7</b>	3.4	-1.5	<b>2.8</b>	-26.7	0.0	<b>-23.6</b>
		<b>Total</b>	-	-	-	<b>3.6</b>	<b>33.6</b>	<b>7.1</b>	<b>4.2</b>	<b>36.3</b>	<b>7.9</b>	<b>11.5</b>	<b>44.0</b>	<b>15.2</b>	<b>40.2</b>	<b>0.0</b>	<b>35.5</b>
Av. Fares	Index	Incumbent	1.01	0.90	<b>1.00</b>	1.01	0.89	<b>0.98</b>	1.01	0.88	<b>0.98</b>	1.01	0.89	<b>0.92</b>	0.84	0.88	<b>0.84</b>
		Entrant	-	-	-	1.04	0.92	<b>0.93</b>	1.04	0.91	<b>0.91</b>	1.04	0.92	<b>0.89</b>	0.81	5.57	<b>0.81</b>
	(base =1)	<b>Total</b>	<b>1.01</b>	<b>0.90</b>	<b>1.00</b>	<b>1.01</b>	<b>0.89</b>	<b>0.98</b>	<b>1.01</b>	<b>0.88</b>	<b>0.97</b>	<b>1.01</b>	<b>0.89</b>	<b>0.92</b>	<b>0.83</b>	<b>0.88</b>	<b>0.83</b>
	%Change	Incumbent	-	-	-	0.0	-1.7	<b>-2.0</b>	0.1	-2.0	<b>-2.2</b>	0.0	-1.5	<b>-7.9</b>	-16.9	0.0	<b>-15.8</b>
		<b>Total</b>	-	-	-	<b>0.4</b>	<b>-1.8</b>	<b>-2.5</b>	<b>0.5</b>	<b>-2.8</b>	<b>-2.9</b>	<b>0.3</b>	<b>-1.1</b>	<b>-8.2</b>	<b>-18.1</b>	<b>0.0</b>	<b>-17.1</b>

**Table 2: Indexed Changes in profits, surplus and infrastructure revenues for Base and Scenarios**

		Base: No competition			Scenario 1: Niche Market Entry			Scenario 2: Niche Market Entry with 10% fares reduction			Scenario 3: Niche Market Entry with 10% fares reduction for Entrant and Incumbent			Scenario 4: Head on Competition		
		Dom	Int	Total	Dom	Int	Total	Dom	Int	Total	Dom	Int	Total	Dom	Int	Total
Profits as proportion of base profit (base total=1)	Incumbent	1.41	-0.41	<b>1.00</b>	0.83	-0.49	<b>0.35</b>	0.76	-0.50	<b>0.26</b>	0.88	-0.49	<b>0.39</b>	-2.65	-0.39	<b>-3.04</b>
	Entrant	-	-	-	0.75	-0.87	<b>-0.13</b>	0.84	-0.86	<b>-0.02</b>	0.76	-0.87	<b>-0.11</b>	-1.74	0.00	<b>-1.74</b>
	Total	-	-	-	1.58	-1.36	<b>0.22</b>	1.60	-1.36	<b>0.24</b>	1.64	-1.35	<b>0.29</b>	-4.39	-0.39	<b>-4.78</b>
Change C.Surplus as proportion of change in profit		-	-	-	-0.35	-0.34	<b>-0.68</b>	-0.40	-0.36	<b>-0.76</b>	-1.18	-0.47	<b>-1.65</b>	-0.24	0.00	<b>-0.24</b>
Change in Net Infrastructure Revenue as proportion of change in profit						-0.13	<b>-0.13</b>		-0.13	<b>-0.13</b>		-0.14	<b>-0.14</b>	0.16		<b>0.16</b>

**Table 3: Indexed Changes in profits, surplus and infrastructure revenues for Base and Scenarios (including 10% cost efficiencies)**

		Scenario 1: Niche Market Entry			Scenario 2: Niche Market Entry with 10% fares reduction			Scenario 3: Niche Market Entry with 10% fares reduction for Entrant and Incumbent			Scenario 4: Head on Competition					
		Dom	Int	Total	Dom	Int	Total	Dom	Int	Total	Dom	Int	Total			
Profits as proportion of base profit (base total=1)	Incumbent			<b>1.20</b>	1.51	-0.40	<b>1.11</b>	1.63	-0.39	<b>1.25</b>	-1.92	-0.30	<b>-2.22</b>			
	Entrant	-	-	-	0.75	-0.77	<b>-0.02</b>	0.84	-0.76	<b>0.08</b>	-1.13	0.00	<b>-1.13</b>			
	Total	-	-	-	<b>2.34</b>	<b>-1.16</b>	<b>1.18</b>	<b>2.35</b>	<b>-1.16</b>	<b>1.19</b>	<b>2.39</b>	<b>-1.15</b>	<b>1.24</b>	<b>-3.05</b>	<b>-0.30</b>	<b>-3.35</b>
Change C.Surplus as proportion of change in profit		-	-	-	1.53	1.49	<b>3.02</b>	1.60	1.45	<b>3.05</b>	3.48	1.41	<b>4.89</b>	-0.32	0.00	<b>-0.32</b>
Change in Net Infrastructure Revenue as proportion of change in profit		-	-	-		0.56	<b>0.56</b>		0.52	<b>0.52</b>		0.41	<b>0.41</b>	0.22		<b>0.22</b>

#### ***4.2 Case Study Results***

Because of the confidentiality of the data, we have scaled the results presented in Table 1 in such a way that demand, revenue, passenger kms and average fares are all presented as indexes, where in each case, the base index is 1. For demand, revenue and passenger kms this index represents the base total over the domestic (dom) and international (int) services. Through the scenarios, this total is further split between incumbent and entrant. Where the total index rises above 1, this indicates market growth, for example in demand. In the case of fares the base index of 1 represents the average fare level taken over all the incumbent's services. This approach allows us to comment on the relative changes between scenarios, but not reveal the absolute figures involved.

#### ***Base***

The base demand figures in Table 1 show that in terms of passengers, the domestic flows on our case study represent 93% of total demand, 92% of total revenue, and 88% of passenger kilometres. The average fare index shows that international average fares are on average around 11% lower than domestic fares. This reflects that demand on the domestic flows contains much more business traffic and is much more concentrated in the peak than the international flows.

#### ***Scenario***

As shown in the Table 1, the result of the new entry is an overall 5.9% rise in demand, a 3.7% rise in revenue in the corridor and a 7.1% increase in total passenger kms. The increase in capacity offered by the new services means that the actual mean fare charges declines by some 2.5%. The incumbent would lose around 4.3% of its demand 5.7% of its revenue on this route. Whilst the effect of competition is greater on international rather than domestic flows, because of the higher share of domestic flows, most of the change in passengers is from international services. The incumbent will also lose 4.3% of its demand and passenger kms. The new entrant would gain two thirds of its revenue from the domestic market. Thus it would be reasonable to say that the proposed service would take most of its revenue from the domestic market rather than international traffic, which might lead to questioning as to whether it is a genuine international service at all. It may be that this diversion is overstated to the extent that passengers might be reluctant to tie themselves to a very low frequency operator over the domestic section of route if there is doubt about reliability, where there is a high frequency alternative that offers the assurance of another service should the one they are booked on fail to operate.

#### *Scenario 2.*

In Scenario 2, with the entrant's 10% fares cut, Table 1 shows there is an increase in rail demand of 6.6%, and a 3.9% increase in revenue on the corridor. As would be expected following a fares cut by the entrant, the outcome for the incumbent is worse than Scenario 1 with revenues falling by 6.5% overall, most of which (6.1%) is from the fall in revenue in the domestic market. It is interesting to note that the ex-post reduction in average fares for the entrant from Scenario 1 to Scenario 2 is only around 2.8%. The initial 10% fare cut leads to an increase in demand which in turn increases ticket prices for the entrant through the yield management system, partially offsetting the original fare cut of 10%. The yield management system dampens the effect of the fare cut.

#### *Scenario 3*

Table 1 shows that the incumbent can restore its position in terms of revenue by a similar fares cut. In this situation, demand in the corridor rises by 14% and revenue by 4% although the incumbent's revenue is

still 5%. Again, the yield management system dampens the effect of the fare cut, and ex-post fares are reduced by around 6% (from Scenario 1) overall.

#### *Scenario 4*

This scenario examines the potential effect of head on competition on a key domestic flow, whereby a new entrant essentially duplicates the existing service and leads to an even split of the resulting demand and revenue across the two operators. International services remain unaffected. Although this is not explicitly shown here as there are other domestic services which are also unaffected, overall the entrant claims around 48% of the domestic market share (ie a demand index of 0.62 for domestic services as against 1.31 for all domestic services). Similarly, the entrant claims 48% of the domestic revenue and passenger kms. Given the way the yield management system works, this head on competition leads to a 18.1% reduction in actual average fares on domestic flows, and the increased frequency and reduced fares between them result in a 40.1% rise in traffic but only a 16.8% increase in revenue.

To summarise then, the first three scenarios lead to a similar modest increase in total revenue and traffic on the route, with the new entrant taking around 10% of the market for the set of origins and destinations modelled. Two thirds of the entrant's revenue would come from the domestic market. Obviously if the entrant cuts fares (Scenario 2), the outcome for the incumbent is slightly worse, although it can restore and improve its position in terms of revenue by a similar fares cut (Scenario 3). Under Scenario 4, the case of head-on competition, whereby a new entrant essentially duplicates the largest existing domestic service, the result is a very high rise in passenger km but the increase in revenue is less than half as much, as the presence of the additional capacity drives down fares. The incumbent loses a lot of the revenue on the route. Not surprisingly, this scenario also sees the greatest fall in average fares, in tandem with a major reduction in load factors.

#### ***4.3 Costs and benefits of entry***

There is clearly a trade off between the benefits to passengers of higher frequencies and lower fares, and the loss of revenue to the incumbent, together with any consequential impacts on what the incumbent can afford to pay for track access, and on what else (for instance cross subsidising other long distance services) those profits might have been used for. Table 2 shows the results in terms of changes in consumer surplus (as a proportion of the change in profits), using logsums derived from the discrete choice model as shown by Williams (21). Table 2 also reports profitability of the rail services and the change in the surplus of track access charges over marginal cost (as a proportion of base profit level). In this table we assume that any ability of the entrant to reduce costs by higher productivity or lower wages is offset by loss of economies of density, so that costs remain unchanged.

It will be seen that in the base situation, the domestic service is highly profitable but the international one loses money. In all scenarios the entrant loses money; the only case where it is close to breakeven is where it cuts fares but the incumbent does not retaliate (an unlikely scenario, given that the incumbent minimises its loss of profits by following suit and cutting fares). In every case the profits of the incumbent (which are currently ploughed back into the rail sector presumably in the form of cross subsidy) are reduced; in the case of head on competition they become strongly negative. It thus appears that on track competition is not sustainable unless the entrant at least has substantially lower costs, and/or the incumbent substantially cuts services and/or track access charges are reduced. It should be remembered that current track access charges do exceed marginal cost in order to make a contribution to fixed costs, so the running of additional trains will add to this contribution. However, if track access charges were reduced enough to make the train services profitable, then in all cases the contribution made to infrastructure costs would reduce, and increased government subsidies would be necessary.

The changes in consumer surplus are positive but generally less than the change (reduction) in profits except for one case: that where both entrant and incumbent cut fares. Thus it appear that there would be a case in cost benefit terms for the government to provide subsidies in order to enable lower rail fares.

Whether this would be best achieved by a franchising system or on track competition remains a key issue however. This will be discussed further in the conclusion.

We have explained above that we consider it doubtful whether on track competition would reduce costs below what could be achieved through a competitively tendered franchise system, particularly given loss of economies of traffic density. But Table 3 shows what would happen if the entrant had costs 10% below the existing level and if this resulted in the incumbent achieving a similar reduction in cost. All figures are expressed relative to the same base as in Table 2. Obviously this reduction in costs achieves a significant increase in profits for both entrant and incumbent. In every case, except for head on competition, the incumbent gains profits relative to the base position, whilst the entrant comes close to break even. For all these cases, niche market entry now has net social benefits, although head on competition does not. However, whether niche market entry would be sufficient to have such a drastic impact on the costs of the incumbent seems doubtful.

## **5 CONCLUSIONS**

Whether to permit open access competition on domestic commercial rail passenger services remains a key issue in the further development of European rail policy. It is already permitted in international traffic, but little has so far happened in that market. There is growing experience of open access competition in the domestic market, but the two main examples have only happened in the last year and it is too soon to judge their long term impact.

This paper has simulated the effects of introducing competition on a long distance international passenger route where there is also a strong domestic market served by high speed trains. We are aware of a number of proposals to introduce new services in such circumstances. It has allowed for the fact that on such a service seat reservations are likely to be compulsory and yield management practiced, so that whatever is

initially assumed about fares there will be further endogenous changes in average fares to maintain high load factors. As far as we are aware this is the first such study to have been able to deal with these issues. It is found that on-track competition has benefits to consumers, in terms of fares and services, but that it would reduce the profitability of the incumbent and that it would be difficult for the new entrant to attain profitability unless its costs were significantly lower than those of the incumbent. A large part of the revenue of the entrant on this route would come from the domestic market, and if open access competition were permitted then the entrant might seek to run a frequent service offering head on competition on this part of the route. However, again it would appear that both operators would make heavy losses in this situation. One way of restoring profitability might be to reduce track access charges, but that would require additional government subsidy to the infrastructure manager, as the additional train kilometres run would not compensate for the lower charges.

By contrast we have seen that for a niche market entry, a 10% cost reduction by both entrant and incumbent as a result of on track competition would be sufficient to restore profitability to the incumbent and come close to making the entrant profitable for niche market entry scenarios (but not for on track competition). Thus a key question is whether open access entry will lead to lower costs, or other innovations in terms of quality of service. Whilst an entrant might well be expected to be able to adopt more efficient working practices and pay lower wages than an existing public sector monopoly, and these might ultimately lead the incumbent to follow suit (although it is doubtful whether niche market entry would be sufficient to have this effect on the incumbent), both would lose in terms of loss of economies of density. An alternative way of achieving the aim of cost reduction which does not have this disadvantage is through competition for the market by means of franchising. A monopoly franchise has the advantage of maintaining economies of traffic density and, provided that the contract was specified so as to give appropriate incentives, may also lead to innovations in terms of quality of service. We have also seen that a reduction in fares associated with reduced profits or subsidies might be desirable; again this can be achieved through a franchise competition with appropriate fares regulation if this is desired.

Thus there seems to be reason to doubt the effectiveness of open access competition as a way of improving the efficiency of rail passenger services. There is one proviso however. Whilst in most of the countries that have used franchising, quality of service has improved and costs reduced, in the one country that has used franchising for all services including commercial ones, Britain, costs have actually increased. If the reasons for this are more than simply specific peculiarities of the British situation, then open access competition may still have a role to play in driving down costs.

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