RAIL INFRASTRUCTURE CHARGES - THE ISSUE OF SCARCITY

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Abstract

European legislation now requires rail infrastructure charges to be based on marginal social cost, although with mark ups permitted for financial reasons, and external costs only have to be charged for when the same is true for competing modes. It also permits charging for scarce capacity, although subject to a capacity review being undertaken. The European Commission High Level Group on infrastructure charges saw charging for spare capacity as being a crucial element in rail infrastructure charges, and in many countries, including Britain, this is clearly a major element in the marginal social cost of rail use. However, there is a shortage of research on how charging for scarce capacity is to be achieved. The existing capacity charges in Britain are based on congestion rather than absolute scarcity, and in those other countries where charges are higher on busy routes than elsewhere, the differential does not appear to be based on any well thought through methodology.

There are broadly two approaches to the measurement of the opportunity cost of scarce capacity. The first is a market led approach in which train operating companies bid for that capacity. Given the need for a set of slots in order to put together a sensible timetable, it is difficult to see how such a bidding process to reveal the value of individual slots could be organised. One possibility is to pre package the slots, but that requires prior knowledge about the set of services the operator wishes to provide; an alternative is an iterative procedure which could however be very time-consuming. Also, the result will at best reveal the value placed on the slot by the operator; only if the subsidy regime gives appropriate incentives in terms of social benefits will this correspond to the social value of the use of the slot.

The second approach is via social cost benefit analysis. Methodologies and data exist with which to quantify the social benefits of alternative uses of a particular slot, including valuing overcrowding and people being unable to travel at their preferred time or by their preferred mode. However, the information requirements necessary to apply these methods are stringent; strictly the best alternative use of the slot has to be known, and extensive information on relevant values, elasticities and cross elasticities is also needed. In particular the extent to which traffic will divert to road, and the nature of the roads that would be used, needs to be known in order to quantify the benefits of the service in terms of the relief of congestion, environmental and accident costs of road traffic. In a congested country without an adequate system of charging for the use of roads this is a crucial element in the appraisal.
Both approaches to charging for scarcity are problematic. Moreover, the cost-
benefit approach only gives the true opportunity cost as part of a calculation
that itself reveals the optimal allocation of capacity. It is true that a charging
approach that reflected the cost of scarcity might help give appropriate
incentives to train operating companies to take into account in their longer
term planning. But for short term allocation decisions it appears that a planned
approach based on social cost-benefit analysis is the most appropriate
approach.

1. Introduction

Use of a piece of transport infrastructure, such as a road or a railway,
consumes the capacity of that asset. Where that capacity is fixed in the short
run, greater utilization of the capacity of that asset begins to lead to shortages
in capacity. On roads, shortages in capacity lead to congestion, which usually
manifests itself as the reduction of traffic speeds to below free-flow speed
and/or the occurrence of queuing at junctions. However, since rail
infrastructure managers control access to the network on a planned basis,
shortages in capacity on the rail network manifest themselves in a different
form. Indeed, it is useful to distinguish between two effects of increased
capacity utilization – congestion and scarcity.

Congestion on the rail network represents the expected delays resulting from
the transmission of delays from one train to another. The introduction of an
additional rail service onto the network reduces the infrastructure manager’s
ability to recover from an incident and increases the probability of delays.
This becomes worse at high levels of capacity utilisation, since there is a lack
of spare capacity to recover from any delays. Congestion costs are the costs
associated with these expected delays. In this way, the utilization of
additional capacity and the resulting congestion on the network imposes delay
costs on train operators and, ultimately, rail passengers.

Scarcity on the rail network represents the inability of a train operator to obtain
the path they want, in terms of departure time, stopping pattern or speed. For
example, a train operator may identify a demand for a train service from A to
B at a particular time and at a particular speed but may be unable to operate
the service because of the presence of other train operators’ services on that
part of the network at that time. This then results in the operator running its
service at a time different to that which it would wish to and/or at a slower
speed than it would wish to; in the extreme, the operator may decide not to, or
be unable to, introduce the service at all. The inability of the train operator to
provide the service it estimates will best meet its customers’ demands
represents a cost to society equal to the social value of that train service;
where social value comprises profit to the train operating company, consumer
surplus to the user and net benefits to third parties for instance from changes
in pollution (which may be positive or negative, in that whilst rail transport itself
creates pollution, it typically does so to a lesser degree than the road or air
transport that might otherwise be used by the traffic in question).
So, scarcity and congestion occur on the rail network when and where capacity utilization is high. Capacity utilization is measured by the number of train services operated, as a proportion of the maximum number of train services which could be operated without congestion, given the infrastructure and signaling systems. However, rail capacity cannot be unambiguously defined as it depends on the pattern of train services on a section of track, particularly the relative speeds of trains and the number of stops, and the infrastructure manager’s flexibility to adjust train times. The difficulty in clearly defining rail capacity is a key barrier to designing means of dealing with rail scarcity and congestion.

In order to understand whether or not capacity is being used in the best possible way it is necessary to find a means of taking account of both scarcity and congestion costs. Of these, scarcity costs were identified as the dominant consequence of existing capacity constraints on the existing rail network by the High Level Group on Transport Infrastructure Pricing (CEC, 1999). Nevertheless, it is argued here that existing mechanisms for dealing with scarcity on the rail network are generally poor and in need of improvement.

A number of policy and research initiatives seeking to address the issue of rail scarcity are worthy of note:

- the latest in the EU’s ongoing railway reform initiatives which includes a directive on capacity allocation and charging, which came into affect in March 2003;
- the proposals for a ‘capacity utilization policy’, recently brought forward by the SRA in Great Britain;
- an increasing body of research on auctioning as a means of allocating railway capacity efficiently;
- research into alternative charging mechanisms for dealing with capacity allocation.

In an environment where one train operator’s decisions about what services to operate have impacts on other train operators, it is becoming increasingly urgent to devise appropriate economic mechanisms to provide signals for those requesting and allocating infrastructure capacity. This paper reviews the above policy and research initiatives in an effort to assist in the development of such economic mechanisms.

### 2. European Policy

The European Commission has long been concerned to revitalise the European railway industry and promote enhanced international services so as to enable the railways to play a greater role in the European ‘Common Transport Policy’. Hence, throughout the 1990s the Commission developed and pursued a policy of separating infrastructure from operations and opening up operations to new entry in an effort to improve the efficiency and marketing of rail transport (CEC, 1996; and CEC, 1998). This separation of
infrastructure from operations has required the Commission to develop rules regarding how railway infrastructure managers should allocate capacity on their rail infrastructure to train operators wishing to use it and regarding what charges infrastructure managers should levy for use of the infrastructure. In 2000 the European Commission and the 15 member states agreed on a set of principles and procedures to determine the allocation of railway infrastructure capacity and levying of charges which were then embodied in the EU Directive 2001/14 (CEC, 2001).

At the heart of much of the Commission’s railways policy is the assertion that “encouraging optimal use of the railway infrastructure will lead to a reduction in the cost of transport to society” (CEC, 2001). Directive 2001/14 seeks to promote optimal use of the railway infrastructure firstly by requiring charges for infrastructure use to be based on “the cost that is directly incurred as a result of operating the train service” (CEC, 2001) and secondly by requiring national infrastructure managers’ capacity charging and allocation procedures to be fair, to provide infrastructure managers and train operators with appropriate incentives and to provide for flexibility in capacity allocation. The directive also requires the establishment of a regulatory body to oversee the application of the agreed principles and procedures and to act as an appeal body. The directive applies to most domestic and international rail services and came into force as of March 2003.

More specifically, Directive 2001/14 requires that:

- all of the information required for the use of access rights be published in a network statement so as to ensure transparency and non-discriminatory access for all railway undertakings;
- purchasers of railway services be allowed to directly enter the capacity-allocation process;
- charging and capacity allocation schemes permit equal and non-discriminatory access for all train operators and attempt to meet the needs of all users and traffic types in a fair and non-discriminatory manner;
- charging and capacity-allocation schemes encourage railway infrastructure managers to optimise use of their infrastructure;
- capacity allocation schemes provide clear and consistent signals to railway undertakings which lead them to make rational decisions;
- charging and capacity allocation schemes allow for fair competition in the provision of railway services;
- undue constraints are not imposed on the wishes of other undertakings holding, or intending to hold, rights to use the infrastructure;
- the needs of different types of services are properly balanced;
- charging and capacity allocation schemes take account of the effects of increasing utilization of infrastructure capacity;
- charging schemes should provide incentives for infrastructure managers to make appropriate investments where they are economically attractive.
Interestingly, the principles relating to access charges state that the costs directly incurred as a result of operating the train service may (though it is not a requirement) include “a charge which reflects the scarcity of capacity of the identifiable segment of the infrastructure during periods of congestion” (CEC, 2001). However, it does not give any guidance on how these scarcity costs might be estimated. Where scarcity forms an element of the price, the infrastructure manager is obliged to bring forward proposals to remove the scarcity, rather than simply exploiting it to raise charges, unless they can show that such measures would be uneconomic. If scarcity charges have not been levied or have not achieved a satisfactory result, the infrastructure manager may allocate scarce capacity according to a set of priority criteria designed to take account of the social value of one service relative to any other service which would consequently be excluded. The directive also allows infrastructure managers the possibility of levying a charge for capacity that is requested but not used; again, however, there is no guidance on what would be an appropriate level for such a charge.

Wherever it is not possible to satisfy all requests for infrastructure capacity adequately then the directive requires the infrastructure manager to carry out a capacity analysis. This analysis is to identify the reasons for the capacity shortage and what measures might be taken in the short and medium term to ease it. Measures to be considered include re-routing, re-timing, speed alterations and infrastructure enhancements. Subsequent to this, the infrastructure manager is required to produce a ‘Capacity Enhancement Plan’ to determine, on the basis of a cost benefit analysis of the possible measures identified, what action shall be taken to enhance infrastructure capacity.

The infrastructure manager is empowered to require the surrender of a train path which, over a period of at least one month, has been used less than a specified threshold quota (unless this was due to circumstances beyond the operator’s control). Furthermore, the infrastructure manager may take a train operator’s previous record of utilisation of train paths into account when determining priorities in the allocation process.

Thus it appears that the Commission sees infrastructure charges as a key part of the solution of the problem of allocating scarce rail capacity between competing operators but has yet to issue any very clear guidance on how charges should be calculated with this end in mind.

3. Britain’s Capacity Utilization Policy

Of all European countries the one that might be expected to have gone furthest to implement charging or other policies to deal with the problem of scarcity of rail capacity is Great Britain. There are two main reasons for this. Firstly, Britain is the country in which the issue of allocation of capacity between different operators is likely to arise most often. In the passenger sector, there are 25 franchised train operating companies and several other companies, and although direct competition between them is limited (the Regulator has adopted a policy known as moderation of competition under which on-track competition is permitted only if it is judged to offer net social
benefits), they frequently share the same infrastructure. In the freight sector there is complete open access, and whilst one company dominates, its three rivals hold a bigger share of the market than in most European countries.

The second reason is that traffic on the rail network has grown considerably since privatisation, with passenger volumes increasing by approximately 30% and freight volumes by almost 50% between 1994/95 and 2002/03, and 21% more train km being operated. Partly this was simply recovering from the recession of the early 1990s but even after this recovery was complete, over the period 1997/8 to 2002/3 there was a 14% increase in passenger kilometres and a similar increase in passenger train kilometres (SRA, 2003b). This growth has been achieved without any fundamental increase in the capacity of the infrastructure and pressure on the network is greater now than it has ever been. Hence, these successes have lead to greater congestion on the rail network and to capacity becoming increasingly scarce, increasing the likelihood of trains being delayed and making it difficult for operators to secure the train paths they desire at the times they desire them in order to meet the demands of their customers. As a consequence, the Strategic Rail Authority (SRA), the government agency responsible for leading the development of the British rail industry, acknowledges that “performance has dipped and customer satisfaction is at an all time low” (SRA, 2002a).

Furthermore, the Government’s ‘Ten Year Plan’ (DETR, 2000) sets three core targets to be met by the rail industry by 2010. These targets are for 50% growth in passenger kilometres, 80% growth in freight tonne kilometres and a reduction in London area overcrowding. The SRA has also been set an objective to achieve improvements in performance reliability. Major capital investment to help meet these targets is envisaged but this will take some time to deliver so shorter term solutions are required. Also, the SRA argues that “before we take forward new investment we should satisfy ourselves that we are using the existing network in the best possible way” (SRA, 2002b).

In September 2002 the SRA issued a consultation document on its proposals for a policy to improve capacity utilisation (SRA, 2002b). Then in December, in light of the consultation, it published the Statement of Principles (SRA, 2002c) which will underpin that Policy. The SRA state the aims of the Capacity Utilisation Policy as being:

- “To formulate clear strategies for capacity utilisation which will specify the best use of existing network capacity to meet customer needs - balancing service provision, maintenance access and performance levels and taking into account anticipated changes in demand;
- To lead the rail industry in a process to develop these strategies;
- To help identify where investment is most needed” (SRA, 2002c).

Clearly, allocating capacity on a constrained network in an effective, efficient way is much more complicated than simply integrating the access requests of different network users and drafting a timetable. It involves a series of important, sometimes difficult, trade-offs regarding operational issues and the
deployment of resources. The effective capacity of any railway infrastructure – the actual number of trains that can be operated – is determined by the combination of a number of inter-related factors. The SRA identify the following three as being important:

- volume and mix of trains - as the volume of services increases on a route, it becomes more difficult to recover from operational problems and where there is a mix of different train services with varying characteristics on a route, capacity is used less efficiently because, for example, a faster train “catches up” a slower one;
- train running performance – allowances are made, when allocating capacity, for day-to-day variations in running time but these may be minimised where the network and train operators together achieve a high standard of train running performance; and
- infrastructure configuration, maintenance and renewal methodologies and practice - the design of the infrastructure and the processes, techniques and equipment used for maintenance, renewal and enhancement determines the capacity which needs to be allocated for these activities.

The Statement of Principles sets out 5 Policy Principles:

1. The utilisation of capacity should facilitate the SRA’s delivery of its objectives;
2. The SRA will implement the Capacity Utilisation Policy through the National Network and Route Utilisation Strategies;
3. Stakeholders, under the leadership and guidance of the SRA, will work together to meet the aims of the policy;
4. Options will be appraised using criteria consistent with Government guidelines;
5. The SRA will review and update this Statement of Principles as circumstances require.

The National Network Utilisation Strategy, referred to in the second principle, is a key document. It is intended that it will resolve “fundamental choices” regarding capacity for the development of long distance passenger and freight traffic, resolve choices regarding service development where there is a choice of route for passenger or freight trains and inform investment decisions. Hence, it includes a statement of capacity required for long distance passenger and freight trains (expressed as numbers and characteristics of paths) and a statement about the development of the national network. A route is included in the ‘long-distance statement’ where long distance services constitute a significant proportion of the services on the route, capacity is scarce and there is a mix of traffic. For those routes, the strategy identifies preferred specifications for the network of services for which the SRA wishes to see capacity provided. The ‘development statement’ will be closely linked to the SRA’s Strategic Plan.

In addition, a series of Route Utilisation Strategies are being prepared, under the umbrella of the National Network Utilisation Strategy, to work up forward
plans for key routes. These Route Utilization Strategies will include a statement of priorities for use of available current and future capacity, the reasons for these priorities and how any changes from the existing capacity utilisation should be delivered. They “aim to secure the optimum balance between the volume and mix of trains using the route, robust train running performance and the need for timely and efficient infrastructure maintenance and renewal” (SRA, 2002b). Preparation of these strategies involves developing and appraising a number of scenarios, both to use the existing capacity as effectively as possible and, where appropriate, to incorporate possible investment options. The process of formulating these strategies is intended to be a collaborative one, which will enable industry stakeholders to explore aspirations together. The first two of these strategies, relating to the West Coast and Midland Mainlines, were recently published.

Thus it appears that the approach to the issue in Britain is very much a planned approach in which charges will have no role in the allocation of scarce capacity. This is all the more surprising in that only recently were infrastructure charges reviewed in order to include a so-called capacity charge along with charges for wear and tear; this charge however is really a congestion charge, based on modelling of the way in which delay increases as capacity utilisation rises (Gibson et al, 2002). Whilst in a number of other countries, e.g. Austria and Germany, charges do differ according to how heavily the part of the network in question is used, none seems to have a systematic way of calculating the opportunity cost of slots on parts of the network where capacity is scarce.

4. Market based approaches to the issue of scarcity

In a free market, one would assume that the infrastructure manager would seek to charge each train operating company according to what they were willing to pay, and to design a timetable which yielded them (the infrastructure manager) the maximum revenue. Probably they would enter into some long term contracts which gave specific rights which might prevent short run maximisation of revenue, but which reduced risks for both parties. Designing a timetable which achieved these aims would not by any means be an easy task but at least it would be clear what they were trying to achieve.

For a mixture of political and economic reasons, the market for rail services is, in practice, not usually a free one. There are good economic reasons to suppose that a purely market based determination of rail services will not be optimal - rail services provide benefits to users which cannot always be recouped as revenue, and they provide non user benefits by diverting passengers from more congested and more environmentally polluting modes. At the same time there is often extreme political sensitivity surrounding capacity allocation issues, as they frequently involve conflict between different layers of government responsible for local and long distance services, and allocations which required complete withdrawal of particular services would be bound to arouse strong opposition.
In theory, the most attractive way of simultaneously determining scarcity costs and allocating capacity is to ‘auction’ scarce slots (Nilsson, 2000). This would mean that all slots would go to the highest bidder, and provided that the bids reflected the social value of the train, economic welfare would be maximised.

There are many practical difficulties however, including the complicated ways in which slots can be put together to produce a variety of types of service and the need to acquire an appropriate set of slots to provide a sensible timetable with good utilisation of resources. In response to these difficulties, it is sometimes suggested that a degree of bidding for pre-packaged sets of slots be organised. However, this will not give incentives for train operating companies to explore possibilities to reduce the scarcity costs of the services they operate by changing speed, stopping pattern or route. It is also the case that the willingness to pay for the slot by the train operating company will only reflect its social value to them if appropriate subsidy regimes are in place to reflect the user and non-user benefits – the social value of the train service. Most subsidy regimes do not do this at the level of the individual train, and to do so would be extremely complicated.

It may be argued that similar problems arise in the air transport industry, where a variety of airlines uses each airport and slots for take-off and landing must be secured to operate a particular flight. Given that there is less direct political involvement in what air services are provided, and that increasingly airlines and even airports are in private ownership, one might expect the air transport industry to offer a clear example as to how to deal with the problem of scarcity in capacity for scheduled transport services. However, even for airports there is almost no use of auctioning and scarcity is not usually taken into account in landing charges (DotEcon, 2001).

An alternative approach, recommended by NERA (1998) is not to seek to charge for the short run opportunity cost of capacity but to identify sections of infrastructure where capacity is constrained and to estimate the long run average incremental cost of expanding capacity. However, this is a very difficult concept to measure (the cost of expanding capacity varies enormously according to the exact proposal considered, and it is not easy to relate this to the number of paths created, since they depend on the precise number and order of trains run). It may be argued, however, that more appropriate incentives are given to infrastructure managers if they are allowed to charge the costs of investment they actually undertake, rather than for the scarcity resulting from a lack of investment. As explained above, Directive 2001/14 seeks to get round this problem of incentives by requiring infrastructure managers to undertake studies to determine the cost of expanding capacity, and to test whether this is justified on cost-benefit grounds, where scarcity charges are levied.

5. The cost-benefit approach to dealing with scarcity issues in rail infrastructure

Given these problems with the market based approach, it is perhaps not surprising that when faced with the problem of allocation of scarce rail
capacity, the Strategic Rail Authority in Great Britain decided in favour of a planned approach based on cost-benefit analysis. Yet this approach is also by no means straightforward.

A cost benefit approach could in principle be adopted to determine the opportunity cost of any particular allocation of a slot. But the information requirements are formidable. It is necessary to know what type of train would be displaced and what would happen to its traffic – would it take a different train at a different departure time, route or speed, a different mode or not travel at all? In Britain research has been undertaken into how users respond to all of these alternatives which may be used as a basis for valuation. Most of this research is brought together in the Passenger Demand Forecasting Handbook (ATOC, 2002), and is the basis for valuation generally recommended in the Strategic Rail Authority’s appraisal criteria (SRA, 2003a). For instance, it is possible to use studies of the value people place on departure time shifts to estimate the value to its customers of the cost involved in travelling earlier or later than when they wish. Similarly, the costs of slower speeds may be estimated from passengers’ values of time. Where traffic would otherwise use another mode, it is also necessary to know the costs involved; in the case of roads this means the types of road and the time of day, since the marginal social costs of road use vary greatly with place and time (Sansom et al, 2001).

An attempt to implement this kind of approach to calculating scarcity costs for the Trans-Pennine route between Leeds and Manchester (Table 1) found that the consumer surplus and external elements of the value might be substantial so certainly an approach which ignored these would be flawed. Also the value of different types of service may vary enormously according to circumstances (Nash et al, 2003) so a simple prioritisation according to the type of train is inadequate. The method employed in that paper first involves identifying the number of ‘standard paths’ – where a standard path is a path which could be used by the dominant type of train on a particular section of track – which would be consumed if a non-standard train – e.g. a train operating at a different speed to others on that track section - were introduced. It then involves measuring the opportunity cost of a standard path, either in terms of the value of an additional standard path to the dominant user of the route (when considering services other than those of the dominant user) or in terms of the value of competing uses of the route (when considering services for the dominant user). Where these are passenger services, existing passenger demand forecasting models may be used to forecast the impact on demand and revenue of the allocation of the additional slot. To this, one then adds the forecast user benefits not captured as revenue, and non user benefits – in particular the proportion of traffic diverted from road and the consequent saving in external cost. Whilst the method is complex, the calculations are the same as those needed to identify the optimal use of capacity; so if that exercise has been undertaken then the necessary data should exist.

However, the point has been made (Quinet, 2003) that if the calculations have already revealed the optimal allocation of capacity, then it is simpler and more straightforward simply to impose this allocation than to seek to achieve it by
means of pricing signals. One response to this is to say that, whilst the calculations themselves may reveal the optimal allocation for the coming timetable, price signals will have a longer term effect on the planning of the different train operating companies. In this case, however, it would not be necessary or even desirable for the charges to reflect the fine detail of the current timetable; what is needed is a charge which gives a reasonable indication of the cost of paths in the longer term. Where expansion of capacity is a realistic proposition, this may mean that a charge based on long run marginal cost is more appropriate in this case than where the charge is designed to achieve optimal current use of existing capacity, as in the case of roads.

6. Conclusions

Dealing with the problem of rail infrastructure capacity scarcity remains an unresolved issue in European rail policy. As we have seen, the idea of charging for scarcity is an important concept in European policy, but no guidance exists on how to calculate the charges in question. Whilst auctioning remains an attractive theoretical possibility, there are many practical problems, and the fact that it has made so little progress in airport landing slots where the practical problems appear much less severe is not encouraging. The direct calculation of the opportunity cost is complex, and requires knowledge of the optimal allocation of capacity in order to be undertaken, so it is of no use for short term capacity allocation decisions. To the extent to which it is helpful to have charges which give longer term incentives to economise in capacity, it may be better to use long run marginal cost as a base, at least where capacity enhancement is likely, but that concept is also hard to apply to the rail sector.

All this suggests that there is no simple answer to the issue of rail capacity allocation, and indeed the best solution will be bound up with many other institutional issues. If it is desired to give competing train operating companies the maximum commercial freedom, then indeed an approach which seeks to align subsidies closely to the benefits given by specific services, and to develop auctioning of slots may be attractive. But in the typical situation in Europe, where either there is a single dominant operator, or operators are tightly controlled by franchise agreements, the cost-benefit based approach appears to be the more promising.

In the meantime, the approach in Britain is essentially a planned approach embodied in the SRA’s Capacity Utilization Policy, a comprehensive planning process to set priorities for the current and future use of capacity. There is scope for this to foster some significant changes in the way the network is used – alterations to timetables, improvements in operating practices, different ways of deploying rolling stock and changes in the ways in which service disruption at times when access is needed for the engineers is minimised. The influence of the policy will only become clearer once more of the route utilization strategies emerge but it does appear that long distance services will be given greater priority and that some reduction in the mix of services on any particular route will be encouraged. It will be interesting, however, to see
how these attempts to improve capacity utilization are constrained by existing franchise commitments and other rigidities in the planning process.

7. References


Quinet, E (2003) Short Term Adjustments in Rail Activity – The Limited Role of Infrastructure Charges. Transport Policy, 10, 1, 73-80

Table 1: Calculation of marginal value per train km
£/ train km

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<thead>
<tr>
<th></th>
<th>Non-Bulk freight</th>
<th>Regional passenger</th>
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<tr>
<td>Marginal infrastructure usage</td>
<td>0.88</td>
<td>0.149</td>
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<tr>
<td>Train operating cost</td>
<td>9.70</td>
<td>5.108</td>
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<td>Air pollution</td>
<td>0.166</td>
<td>0.041</td>
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<td>Noise</td>
<td>0.170</td>
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<td>Climate change</td>
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<td>Congestion</td>
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<td>VAT not paid</td>
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<td>Total cost</td>
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<td>Revenue</td>
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<td>Net Benefit</td>
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Source: Nash, Coulthard and Matthews (2003) For assumptions see original.