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Rail Infrastructure Charges in Europe

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Abstract

This paper reviews results of a survey of rail infrastructure charges in Europe, presenting evidence on the structure and level of charges across 23 countries, and on the rationale behind the charges. A wide variety of both structure and level of charges is found, and it appears there is a range of explanations for this, including differences in the nature and mix of rail traffic, differences in the willingness and ability of governments to provide subsidies, and continued lack of consensus on the measurement of the marginal cost of infrastructure use. Recommendations on a sensible structure for rail infrastructure charges are given, although the need for further research is also acknowledged. The diversity of approach poses problems particularly for international rail freight, and there is a strong argument for the development of a specific set of international rail freight tariffs.

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1.0 Introduction

In Europe, since World War Two, it has been normal for rail services to be provided by a single vertically integrated state owned company. However, rail has continuously lost market share and required steadily increasing subsidies over this period. Moreover, the view is widely held that it has particularly failed to exploit the growing opportunities for long-distance international freight, where the traditional approach of each national rail company handing traffic over to its neighbour at the border has failed to provide the kind of door-to-door quality of service provided by road.

Beginning in 1991 with Directive 91/440, the European Commission has pursued a policy of seeking to introduce competition for the provision of rail services and to achieve new entry by companies that would offer door-to-door service across Europe.

Directive 91/440 introduced the right of access to the infrastructure for limited categories of international freight operators, but that right has been extended to all international rail freight operators on an extensive trans-European rail freight network and by 2007 will apply to all freight, domestic and international, on the entire European Union rail network. Extending the right also to international passenger services is now under discussion. At the same time, a number of countries have introduced competition in the form of competitive tendering for the provision of passenger services under a franchise arrangement. That applies to virtually all passenger services in Great Britain, but also to many services in Sweden and Germany, to some in Denmark and the Netherlands, and to a single route in Portugal.

Simply bestowing rights of access was not, however, sufficient to achieve competition, particularly in the face of strong opposition to open access in some countries. Directives also had to be introduced to cover licensing and safety arrangements (clearly it is essential to restrict access to operators who can satisfy the relevant authorities that they will operate safely, but at the same time it is necessary to guard against this being used as an excuse to prevent entry for protectionist reasons). It was necessary to put in place arrangements to ensure that the allocation of slots was not used as a way to disadvantage new entrants (where the infrastructure manager also provides train services, slot allocation must be done by a separate body, and train operators have the right of appeal to an independent regulator). Last but not least it was necessary to introduce legislation on the subject of infrastructure charges to prevent these from being used as a deliberate barrier to entry.

In the following section we consider the principles behind rail infrastructure charges, and the way in which these are embodied in current

legislation. We then discuss the measurement of the relevant costs before turning to actual practice as it is at present in Europe. Finally we seek to draw conclusions.

2.0 Principles

It has long been recognised that infrastructure charges may be set with a variety of objectives in mind and that these objectives may conflict. Giving appropriate incentives to the train operator to make the best use of existing track capacity means charging short-run marginal social cost, including external effects not just on the rest of society (for example environmental cost) but also on other train operators through additional delays or through making it impossible for them to get the slots they wish. From the point of view of the longer-term development of services it is also important to provide the train operator (or funder of the services, where they are subsidised) with appropriate signals as to the long-run cost of that pattern of service, allowing for the possibility of investment or disinvestment, and to provide signals to the infrastructure manager to undertake such investment or disinvestment (this may be considered less important if the infrastructure manager is under direct government control and required to undertake such decisions on the basis of cost-benefit analysis than if it is a private company reacting solely to financial incentives).

Already, therefore, there is a conflict between charging short-run marginal cost and charging the long-run incremental cost of the set of services in question. An obvious solution to this is to charge a variable charge equal to the short-run marginal cost of the particular train, and a fixed charge equal to the avoidable cost of the set of services as a whole. The fixed charge would be open to renegotiation as part of a long-term access agreement specifying broad access rights, whereas the variable charge would be based on the service actually run in the timetable period in question. Spare slots could be sold on the spot market on the basis of short-run marginal cost but would imply no longer-term access rights.

This is straightforward when there is a single operator, but more complex when different operators share a route. Two factors lead to great difficulties with such calculations in the rail sector:

- the lack of a single clear cut measure of capacity;
- the importance of sunk costs and of indivisibilities and economies of scale.

On the first point, consider the effect of adding additional tracks to a main line shared by operators of fast and stopping passenger services and freight.

How many paths it would create depends heavily on the mix of trains in question. If it was used to transfer all freight and stopping passenger trains from the fast lines, it might create a large number of paths per hour for fast trains. If it was exclusively freight, it might create a somewhat smaller number of freight paths per hour. On the second point the number of paths actually demanded may well be less than those created, particularly away from peak times, and part of the cost of providing this capacity is a sunk cost of preparing the track bed and structures that cannot be recovered if the tracks are abandoned.

The result of all this is that it is impossible to come up with a single long-run marginal cost per path; the cost per path of the services of one operator will vary according to what else is running on the system. What can be calculated is the incremental cost of providing capacity for the services of each operator given what else is running. This will probably leave an element of the capacity cost that is truly joint between them, and which must be recovered in the most efficient way possible. Unless the government in question chooses to fund this directly, this is likely to be by an increase in the fixed part of the tariff to the operator most able to bear it.

In 1995 the Commission published a Green Paper entitled 'Towards Fair and Efficient Pricing in Transport' (Commission of the European Communities, 1995), which broadly espoused the marginal social cost pricing principle, while recognising that there was a conflict between this and recovering the full cost of infrastructure provision. This led to a White Paper in 1998, in which the Commission published its proposals for the introduction of a common transport infrastructure charging framework, which placed a further emphasis on the marginal social cost pricing approach, while allowing non-discriminatory fixed charges to be levied where this is not adequate for full cost recovery (Commission of the European Communities, 1998). Detailed proposals on railway infrastructure charging emerged in Directive 2001/14, on allocation of railway infrastructure capacity and levying of charges. In summary, the directive determines that charges must be based on 'costs directly incurred as a result of operating the train service'. They may include:

- scarcity, although where a section of track is defined as having a scarcity problem, the infrastructure manager must examine proposals to relieve that scarcity, and undertake them unless they are shown, on the basis of cost benefit analysis, not to be worthwhile;
- environmental costs, but only where these are levied on other modes;
- recovery of the costs of specific investments where these are worthwhile and could not otherwise be funded;

- discounts, but only where justified by costs; large operators may not use their market power to get discounts;
- reservation charges for scarce capacity, which must be paid whether the capacity is used or not;
- compensation for unpaid costs on other modes;
- non-discriminatory mark-ups, but these must not exclude segments of traffic which could cover direct cost.

It seems clear from the list of elements that may be included in the charges that 'the direct cost of operating the service' is to be interpreted as short-run marginal social cost. However, the arguments that this form of pricing may lead infrastructure managers to restrict capacity artificially or to be unable to fund their activities in total or particular investments are all addressed by special provisions. Moreover, there is allowance for second-best pricing in the face of distorted prices on other modes.

Of particular concern in the current context are the provisions regarding non-discriminatory mark-ups. It is clear from the Directive that the discrimination referred to here is between different operators of the same type of traffic; discrimination by type of traffic is allowed. However, the Directive specifically states that the average and marginal charges in the tariff should be close. This seems specifically to rule out the sort of two-part tariff discussed above, although in the case of competitive tendering, where whichever operator wins the franchise would pay the same fixed charge, there would appear to be no discrimination between operators. Wherever there is on-track competition, two-part tariffs are highly problematic in terms of meeting the non-discrimination criteria.

The removal of the possibility of two-part tariffs makes it impossible simultaneously to achieve the twin objectives of optimising use of the existing infrastructure and giving appropriate incentives for development of the infrastructure. A choice has to be made between short-run and long-run marginal cost as the basis for pricing. Given the problems already identified with measuring long-run marginal cost of rail capacity, short-run marginal cost pricing seems much more straightforward. If the infrastructure manager can be relied upon to take sensible investment/disinvestment decisions on the basis of cost benefit analysis, then using pricing to promote efficient use of the existing infrastructure and ignoring longer-run development incentives is wholly appropriate. But if a commercial infrastructure manager is combined with on-track competition the problem becomes acute. Moreover, if it is necessary to recover from operators more than just the marginal cost of their use of the infrastructure a further problem is added. It is no longer possible to use fixed charges for this purpose, so the best that can be done is to vary charges with the price elasticity of

demand of the market segment in question — Ramsey pricing. But the knowledge of the infrastructure manager regarding the types of traffic using the system and its price elasticity of demand may be limited to a few broad categories of train. Certainly the infrastructure manager will not be as well placed to discriminate between markets as will the train operator, who deals directly with individual final customers. Thus Ramsey pricing of track access is likely to be more distorting than use of a two-part tariff.

Our discussion of principles has the clear implication that there is no single set of infrastructure charging principles that will be optimal in all circumstances. If the government is willing to fund a large part of infrastructure costs, and takes infrastructure development decisions on the basis of cost benefit analysis, then 'pure' short-run marginal social cost pricing may be the best solution. Where there is a monopoly operator, for instance as a result of a franchise competition, two-part tariffs will be best. Where there is on-track competition, but government funding is limited, marginal cost pricing with mark-ups will be needed. If there is on-track competition on track owned by a private company, then infrastructure pricing is particularly difficult unless the market is sufficiently insensitive to price that simple average cost pricing is not too distorting.

3.0 Empirical Measurement of Costs

The previous section implies that in most circumstances, measurement of short-run marginal social cost will be an essential element in producing an efficient infrastructure charging system. Thus we need to move from principles to measurement. However, there seems to be little agreement currently on what cost elements should enter into short-run marginal social cost and how they should be measured.

In this section we consider the main elements of marginal cost and the way in which they are currently treated in charging systems. Table 1 summarises the cost elements that enter directly into charging systems of the different countries. Broadly they may be summarised as follows.

3.1 Maintenance and renewals

It is generally accepted that while some elements of track maintenance — for example weedkilling — are needed regardless of traffic levels, others — for example ballast cleaning — are influenced by the volume and nature of traffic. Moreover, the same applied to renewals. While deterioration of

Table 1
Cost Elements Entering into Variable Charges

	Maintenance	*Renewals*	*Train Planning and Operations*	*Congestion and Scarcity*	*Accidents*	*Environment*
Austria	✓	×	×	✓	×	×
Czech	✓	×	✓	×	×	×
Denmark	✓	×	×	✓	×	×
Estonia	✓	✓	✓	×	×	×
Finland	✓	✓	×	×	×	✓
France	✓	✓	✓	✓	×	×
Germany	✓	✓	✓	✓	×	×
Hungary	✓	✓	✓	×	×	×
Italy	×	×	✓	✓	×	×
Latvia	✓	✓	✓	×	×	×
Netherlands	✓	×	✓	×	×	×
Poland	✓	✓	✓	×	×	×
Portugal	✓	×	✓	×	×	×
Romania	✓	×	✓	×	×	×
Slovenia	✓	✓	✓	×	×	×
Sweden	✓	×	×	×	✓	✓
Switzerland	✓	✓	✓	✓	×	noise bonus
UK	✓	✓	×	✓	×	×

sleepers and ballast may occur over time regardless of use, this process may be accelerated by traffic passing over them, and rail wear will be almost entirely due to the traffic passing over it.

Maintenance and renewals costs are generally considered to be the main elements of marginal cost to the infrastructure manager and are the only ones for which published econometric evidence exists. Econometric studies of the marginal cost of track maintenance and renewals in European conditions (Thomas, 2002) generally show these to amount to between 10 and 30 per cent of average maintenance and renewals cost. However, most of these studies only consider maintenance cost. Because renewals tend to be bunched, and to depend on traffic levels over a number of previous years, it is much harder to get evidence on the marginal cost of traffic in terms of renewals. In fact, of the econometric studies referred to above, only that for Finland covers both maintenance and renewals. Elsewhere, given the absence of evidence, renewals are often ignored when it comes to the measurement of marginal social cost.

Most econometric studies use gross tonne kilometres as the measure of traffic volumes and do not distinguish between types of trains. Where there is such a distinction in the measurement of marginal cost, it is generally — as in Britain — based on engineering formulae. For instance, in Britain rail wear is taken to depend on equivalent gross tonne miles ($EGTM$) computed

Table 2
Classification of Fixed and Variable Costs in Great Britain

Asset	*Activity*	*Component*	*% Variable*
Track	Maintenance		30
	Renewal	Rail	95
		Sleepers	25
		Ballast	30
Structures	Maintenance & Renewal		10
Signalling	Maintenance		5
	Renewal		0
Electrification	Maintenance		10
	Renewal	AC	35
		DC	41

by the following formula:

$$EGTM = K \cdot C_t \cdot A^{0.49} \cdot S^{0.64} \cdot USM^{0.19} \cdot GTM,$$

where $K =$ constant, $C_t =$ unit type constant, $A =$ axle load, $S =$ speed, and $USM =$ unsprung mass.

To obtain its estimate of the general level of marginal cost of maintenance and renewals Britain takes a rather traditional approach of dividing costs into fixed and variable based on engineering evidence (Table 2) and uses average variable cost as an approximation of marginal cost of maintenance and renewals, but it is important to realise that this is in the context of a definition of variable costs that include only those costs thought to vary with output in the vicinity of current output levels; it gives a cost elasticity not greatly out of line with econometric evidence for other countries and appears to be a reasonable approximation to marginal cost.

3.2 Train planning and operations

There is no such common view on the variability of train planning and operations. While it must surely be the case that staff and facilities required for train planning vary with the volume and complexity of train movements to be planned, it may be that there are such indivisibilities that the marginal cost of additional paths is negligible. Similarly with modern signalling systems the costs of signalling and train control largely take the form of capital investment rather than labour and therefore vary little in the short run.

3.3 Power

Where the infrastructure manager is responsible for supplying electricity, this should be largely a case of passing on the cost. However, there will

be marginal wear and tear costs on the catenary, which might be treated as an add-on to the electricity charge, or as an element of maintenance and renewals cost, obviously charged only to electric traction.

3.4 Other services

Under EU law infrastructure managers are required to offer a basic package and are then allowed to charge for additional services. Such services may include use of stations, depots, marshalling facilities and the provision of information. It seems likely that in most cases the marginal cost of use of such facilities (except where the infrastructure manager provides direct labour inputs) is close to zero but there is no research to follow.

3.5 Congestion and scarcity

Congestion arises where one train delays another. In a planned system such as a railway the timetable is designed to prevent this from happening, but it remains the case that at high levels of utilisation, the presence of an additional train on the tracks may lead to additional delays to other trains by reducing the ability of the system to recover from delays.

Congestion charges should be distinguished from the costs of delays imposed by the infrastructure manager or by one train operator on another. Where these are charged for, they are part of a separate performance regime. Such regimes already exist in Great Britain and Finland, and other countries are examining them.

Scarcity costs arise where the presence of a train prevents another train from operating, or requires it to take an inferior path, while congestion costs only arise when a train actually operates; scarcity costs are incurred whenever a path is reserved for its use. Thus there is a case for the latter to be charged for by means of a reservation fee, but which would only apply where capacity was tight. Obviously both forms of charge should be differentiated in time and space according to the level of capacity utilisation, and according to the capacity the train itself requires, which depends upon how its speed relates to those of other trains.

3.6 Environmental costs

The main elements of marginal environmental costs are noise, local air pollution and global warming. While global warming depends entirely on consumption of carbon based fuels either directly or in the form of electricity (and therefore for those countries in which electricity is largely hydro or nuclear based will be very small), noise and local air pollution effects depend on the characteristics both of the rolling stock and of the locality through which it is passing (in particular population density but also

factors such as wind speed and direction). European research projects have produced estimates of these costs for a variety of circumstances (UNITE, 2004). Obviously it is not usually desirable for these charges to be paid direct to the infrastructure manager if there is any risk of creating perverse incentives to attract environmentally damaging trains to boost income.

3.7 Accident costs

For the most part, train operating companies are responsible for the accident costs they cause, either by bearing them directly or through insurance. However, there are arguments that if running additional trains raises the accident risk either for other trains or for road vehicles at level crossings then there is a difference between marginal external cost imposed on third parties and average cost borne by the user. There is some evidence on this for Sweden (UNITE 2004). It may also be the case that some costs are borne by the state or by those involved in accidents and not fully compensated by the rail operator.

4.0 The Structure of Charges

Table 3 illustrates the structure of charges for the majority of European countries. It will be seen that the most common system is a simple charge per train kilometre, which may be differentiated by type of traction, weight, speed, and axleload of the train. This may be a reasonable way of charging for maintenance and renewals costs, environmental costs, and congestion, although as noted above the first two of these items may vary reasonably closely with gross tonne kilometres. Some countries (such as Finland) only charge per gross tonne kilometre, whilst others (such as Austria) combine gross tonne kilometre charges for wear and tear with charges per train kilometre for other cost elements.

There is a greater diversity of views on the marginal cost of train planning and operations, some countries (such as Finland and implicitly Great Britain) regarding it as totally fixed. Where it is regarded as part of marginal cost, it seems appropriate to charge per planned path (as in Hungary and Italy), with some adjustment according to the complexity of the task of planning the path. The latter may relate to the distance the train travels (so a charge per path-km is another possibility), the number of connections that need to be planned, or the number of congested nodes it needs to be fitted through. Switzerland levies a charge per train-km for train planning and operations; both Switzerland and Italy also have a charge per node, although this may be purely a congestion charge.

Table 3
Structure of Charges

	Pricing Principle	*Fixed Charges*	*Charges per Gross Tonne-km*	*Train-km*	*Path-km*	*Other*
Austria	MC+		✓	✓		
Bulgaria	MC+			✓		
Czech Republic	MC+		✓	✓		
Denmark	MC+			✓		Charges per train for bottlenecks and bridges
Estonia	FC−	✓	✓	✓		
Finland	MC+		✓			
France	MC+	✓		✓	✓	
Germany	FC−			✓		
Hungary	FC			✓	✓	
Italy	FC− (Traffic management only)	✓		✓	✓	Also charge per node
Latvia	FC			✓		
Netherlands	MC			✓		
Poland	FC			✓	✓	
Portugal	MC			✓		
Romania	FC	✓	✓		✓	
Slovenia	FC			✓		
Sweden	MC+		✓			Øresund bridge surcharge
Switzerland	MC+		✓	✓		Also charge per node
UK	MC+	Franchisees only		✓		Per vehicle km by type of vehicle

Slovenia is proposing an additional charge for use of lines outside the normal hours of operation. The charge per train-km in Germany varies as to whether the path sought is express, regular interval, or economy. Switzerland has a surcharge for dangerous goods.

France has a tariff incorporating a monthly track access charge that is designed to recover the costs of train planning. This is differentiated according to the number of paths requested, increasing much less rapidly than the number of paths. Although this charge only accounts for 4 per cent of current revenues from infrastructure charges as a whole, and thus 4 per cent of the charges paid by SNCF, it could amount to a very much more significant element of costs for a small operator, since the cost per path is ten times higher for a small number of train paths. The charge is to be modified from the beginning of 2006 to eliminate the bias against small operators.

Only Great Britain has a congestion charge per train-km explicitly related to estimates of congestion costs. However, charges per train-km in Italy and Germany vary by train speed and type of route. In Germany there is an explicit utilisation factor, with a higher charge for heavily used lines. Italy uses a simple approach of setting standard speed profiles for each route designed to optimise the line, and charging higher prices for paths that deviate from the profile, either by seeking faster or slower paths that disrupt the optimal service profile. Slovenia is proposing an off-peak discount. There is also a charge per node in Switzerland and Italy that varies with the implicit amount of congestion at the node by categorising nodes according to traffic levels.

As noted above, when charging for scarcity it is appropriate to levy a reservation charge, regardless of whether the reserved path is used or not. France has such a charge. Switzerland has a train path cancellation charge. This seems a curious way of dealing with the issue, as it is likely to hamper rather than help the reallocation of paths to higher value uses. Germany (and the proposals for Slovenia) charges more for ad hoc paths than for regular paths, which is the opposite of a reservation fee, but may be justified in terms of costs of train planning.

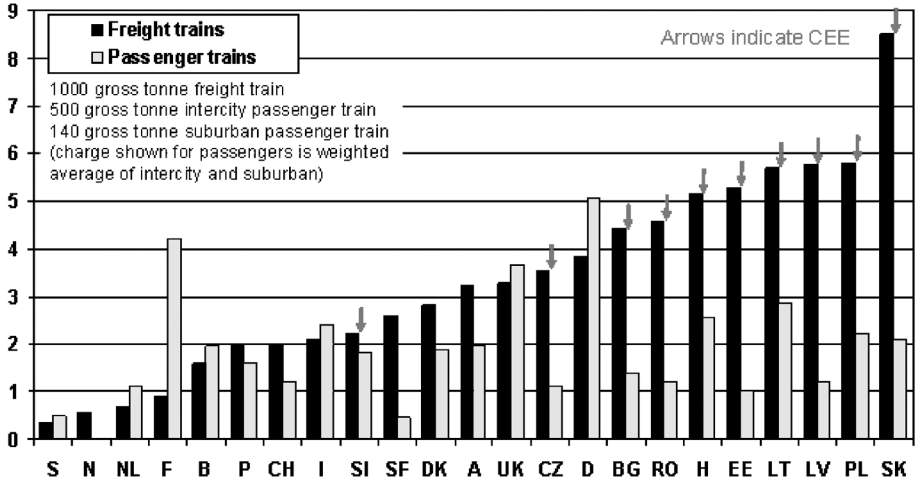
In addition to the basic track access charges, some systems have charges for the use of stations, depots and marshalling yards, or for other supplementary services (for instance there is a passenger information surcharge on passenger train gross tonne-km in Sweden). It appears that typically these charges are based on average rather than marginal cost and, although in most cases they do not appear to be a large part of the total charge, it is possible that they both distort traffic levels and discourage entry, particularly where the charge is for use of a facility that the incumbent operator provides. A few countries have emissions charges levied on diesel fuel for

rail traction and paid direct to the government (examples are Finland, Norway, Sweden). Obviously these charges do not vary in time and space, and are therefore only strictly appropriate for reflecting costs such as global warming, rather than local air pollution costs, which do vary with these factors. There is a charge for accident costs in the Swedish system.

5.0 The Level of Charges

Figure 1 illustrates typical levels of charge for passenger and freight trains per train kilometre. It will be seen that these vary from less than one euro per train kilometre in Scandinavia to charges of five or six euros per train kilometre for freight in Eastern Europe (and considerably more than that in the case of Slovakia). While some of the difference may be due to genuine differences in cost as a result of ground conditions, wage levels and types of traffic (for instance the average weight of trains) it is likely that much of the difference is due to differences in the degree to which governments are willing and able to bear a large part of the costs of the infrastructure. Thus Scandinavian countries aim at genuine short-run marginal cost pricing (and may actually charge below marginal cost because of the failure to charge for marginal renewals cost) while many Central and Eastern European countries aim at full cost recovery because of a simple shortage of government resources.

Figure 1
Typical levels of charges



Three countries, Britain, France, and Germany, stand out as having high charges for passenger trains. In Britain and France this is achieved via a two-part tariff in a sector where there is little or no on-track competition. Germany aims at a high level of cost recovery, recovering all costs except for some capital costs from users, but abandoned two-part tariffs in the face of objections from competitors. Freight tariffs are high in the former communist countries of the CEE. In the Baltic states, where most of the freight traffic is completing a long haul between Russia and the ports, the high tariffs may not have a serious effect on traffic. Elsewhere, there is a serious danger that in many cases these tariffs are set to achieve full cost recovery without consideration of the competitive position of rail freight, and without adequate examination of unpopular options such as rationalisation to reduce costs (CER, 2004).

Mark-ups come essentially in two forms: fixed charges as part of a two-part tariff, and mark-ups on variable charges. The latter will be a charge per train-km (or vehicle or gross tonne-km) varying with the nature of the traffic the train carries.

Britain, Italy, France, Bulgaria, Hungary, Lithuania, and Romania have two-part tariffs. Where the 'fixed' part of the tariff is in fact a charge per path or per path-km, it may of course simply reflect marginal costs of train planning or of scarcity, and a mark-up applied to this is similar to a mark-up per train-km. A true fixed charge will be a lump sum for access to the infrastructure (possibly related to the route length accessed, as with the two-part tariff that used to exist in Germany).

Fixed charges are attractive inasmuch as they permit mark-ups without distorting the incentives to train operators regarding the number and types of trains to run. But unless the fixed element is designed carefully it may create distortions by preventing some operators from accessing the system at all and by biasing the terms of competition between large and small operators.

In Britain, the fixed element is charged only to passenger franchisees, and covers their avoidable costs (that is, not just variable costs but also any fixed costs that would be avoided if the particular set of services was no longer running) plus a share of all remaining joint and fixed costs. This charge is simply reflected in the payment the franchisee receives for operating the franchise, and therefore there is no need for differentiation according to ability to pay at the level of individual trains or train types. The franchise system allows fixed costs to be passed on in a fixed charge without any distortion of competition.

Elsewhere (for example in Germany, Switzerland) mark-ups take the form of variable charges and are generally related to the type of traffic. In some cases (Finland, Sweden, Switzerland, Denmark) mark-ups are

used on new routes to contribute to their financing costs. It is doubtful whether mark-ups on specific routes to help fund capital costs are efficient; there is no reason to suppose that elasticities are systematically lower on those routes than elsewhere, although some of these routes involve bridges where there is a toll on road traffic too, and there a mark-up may be feasible without inter-modal distortion.

One example of incentives created by high mark-ups on new facilities is the approach in Denmark and Sweden to recovering the cost of the Øresund Bridge (connecting Denmark and Sweden) and the Storebælt Bridge (connecting the Danish islands of Zealand and Funen), furnishing the direct rail connection between Denmark, Sweden and Germany. The access charge to the Øresund Bridge is a fixed amount per freight train, €286 on the Danish side and €255 per freight train on the Swedish side, a total of €541 per freight train (the passenger charge is €210 per train on the Danish side only). Access charges for the Storebælt Bridge are €873 per freight train and €941 per passenger train. Taking the bridge charges together, a freight train from Sweden to Germany would pay €1,414: this is equivalent to almost 6,000 km of train charges at the current Danish main line access charge (excluding bridge and congestion charges). It furnishes a powerful incentive to run the longest possible freight trains, which will reduce bridge charges but at the cost of reduced service frequency for freight shippers. By comparison, a simple charge per gross tonne-km would have no effect on the length of freight trains, and would not affect service levels.

This example is instructive on the effect of charging access charges well above marginal cost: the high Danish and Swedish tolls, imposed in order to pay back the debt from building the bridge, clearly must suppress rail traffic across the bridges and affect the structure and service levels of freight services for the transit traffic from Sweden to Germany and beyond.

Differences in charges between routes, areas and market segments may reflect differences in willingness to pay, and therefore raise the necessary revenue in the least distorting way, although they may also reflect other principles (such as the avoidable costs of the category of traffic, or the route, in question). It should be noted that the number of identified categories of train, and therefore the degree of price discrimination, is usually quite small. The infrastructure manager has much less ability to differentiate price, for instance between passengers or containers on a given train, than the train operator. Two-part tariffs may therefore distort prices less than mark-ups on the variable charge for infrastructure use, even when they require train operators to recover more than marginal costs in the final market.

There is a particular problem about mark-ups on international traffic. This is the so-called double marginalisation problem (Bassanini and Pouyet, 2000): if each country puts on a mark-up that is most profitable relating to its own costs and revenues, the net effect is a much greater mark-up than if a single operator designed a mark-up that was optimal for the flow of traffic over the route as a whole. This suggests a need for specific rules concerning mark-ups on international traffic, if indeed they should be permitted at all. Ideally, if a mark-up is required on international traffic it would be better that it should be negotiated by the infrastructure managers concerned amongst themselves, rather than simply be the result of adding domestic tariffs together regardless of the competitiveness of the resulting charge.

One final point should be made regarding mark-ups. There is always a fear that dominant operators will use their market power to secure favourable treatment, and this fear is particularly strong where the dominant operator is part of the same organisation as the infrastructure manager. Straightforward discrimination between particular operators is of course illegal under EU legislation, but it is possible to design mark-ups that favour the dominant operator, for instance through two-part tariffs or by unfavourable treatment of traffic in which the threat of entry is strongest. Similar effects may be achieved by manipulating the charges for individual services, and particularly services that the dominant operator provides for itself.

6.0 Policy Implications

Given the wide range of experience outlined above what can be said by way of general policy conclusions? Some conclusions are straightforward. In countries where there is little or no competition (such as Finland), congestion and scarcity costs may be irrelevant to the charging system as they are already internalised to the single operator (who will nevertheless need to examine their magnitude to make sensible decisions). Moreover, in Finland, there is little mark-up on marginal social costs in the tariff — the state pays 86 per cent of infrastructure costs. Thus it is not surprising to find a much simpler tariff in Finland than in, say, Britain or Germany, both of which have many different operators and a requirement to fund a much higher proportion of infrastructure costs through access charges.

A common approach is to have a charge per train-km along with a charge per gross tonne-km, differentiated to a greater or lesser degree by type of train and type of track. This can be adequately differentiated to reflect differences in weight, axle load, speed, and quality of track, and

thus can appropriately recover marginal maintenance and renewal costs. Appropriately differentiated by location, type of traction, and time of day, it can also reflect congestion and external costs. In general charges that accurately reflected short run marginal social cost would need to differentiate train-km charges by time, location, infrastructure characteristics (higher charges on lower quality track), and rolling stock characteristics (type of traction, gross weight, axle load and speed).

The only charges that cannot be appropriately represented by a differentiated charge per train-km and gross tonne-km are those that reflect costs that are incurred whether the train actually runs or not; namely train planning and, where a slot is reserved for the train, scarcity. For these costs it seems appropriate to charge per path-km. For scarcity charges, this would again need to be differentiated by location, time of day, and possibly speed relative to the typical speed on the route in question, and could include a charge per node.

Where mark-ups are needed to boost cost recovery, there is a considerable problem. Fixed charges, as long as they reflect the ability to pay of the operator, are least distorting in terms of their incentives regarding train-kilometres run, but are likely to distort competition between large and small operators and this is the typical form of competition in Europe. They are therefore only likely to be acceptable in the case of monopoly franchises (which support competition for, rather than in the market). Elsewhere, the best solution is likely to be a mark-up per train-km and/or gross tonne-km based on market segment, although it is questionable whether these should be permitted on international freight trains (or whether there should be some kind of cap). Surcharges may make sense where high quality service or market position make this feasible without significant loss of traffic, but it should not be considered that simply because expensive new infrastructure is in place, that alone justifies a surcharge regardless of the effect on the market.

For ancillary services, such as the use of stations or marshalling yards, a charge per train or per wagon would seem appropriate, but again possibly differentiated by market segment, train length, and the length of time the train or wagon uses the facility if capacity is scarce.

It is clear that marginal social cost based charges could therefore appear quite complex even if based largely on a differentiated charge per train-km or path-km. To what extent such complexities are worthwhile in terms of the impact of the incentives they produce is an empirical question, and there seems little empirical evidence (the example was quoted in ECMT 2005 of a charge for open coal wagons for the contamination of ballast by coal dust leading to the fitting of hoods on wagons as support for very detailed incentives). It also seems likely that the degree of differentiation that is

optimal will depend very much on the characteristics of the network and the traffic using it; the simpler and less congested it is, the less the case for complicated tariffs. However, for international traffic, the existence of very different degrees of differentiation of charges in different countries along the route is certainly a complicating factor. This may support the idea of separate international tariffs, negotiated between or among the infrastructure managers concerned, at least on key international routes.

7.0 Conclusions

We have seen that there are some difficult issues to resolve in designing a rail infrastructure charging regime. The first is a matter of principle; a single charge per train kilometre cannot both give the correct incentives for the optimal use of the existing infrastructure and the right signals for the future development of the infrastructure through investment or disinvestment. One solution to this is to charge according to a two-part tariff, where the variable element reflects the short-run marginal social cost of the use of the existing infrastructure, and the fixed element reflects the avoidable cost of providing the capacity made available to the operator under a framework agreement. An operator could simply buy capacity on the spot market at short-run marginal cost but then would gain no longer-term access rights.

This solution is wholly appropriate in the case of monopoly franchises, such as are often applied in Europe to passenger services, but is much more problematic in the case of on-track completion as exists mainly for freight, as the fixed charge has to be divided between competitors in a non-discriminatory way. In practice European legislation essentially rules out two-part tariffs in such cases, requiring charges to be based on marginal social cost plus a mark-up that may differentiate between market segments but not between operators.

Despite a great deal of research work, there is still no general agreement on how actually to measure and calculate rail infrastructure marginal costs or external costs. There is an urgent need for a common approach to ensure that at least the basic wear and tear costs, including accelerated renewals, are recovered from users. Only second-best arguments, based on under-charging on other modes, could justify failing to do this. Acknowledging the difficulty of measuring marginal cost (including renewals), there are a number of cases in which the access charge regime almost certainly has charges below marginal cost, even without renewals. The Swedish access charge regime only collects a small proportion of its costs from users, an

amount that falls well below the rule of thumb that the variable costs of maintenance and renewals are about 10 to 30 per cent of average maintenance and renewals costs. Access charges in Norway and Denmark (except for the bridge tolls discussed elsewhere) are comparable in level with Sweden, and must also be below marginal cost when renewals are taken into account. Norway does not charge for passenger trains at all, an approach that is by definition below marginal cost. A number of countries explicitly do not attempt to recover the cost of renewal in their access regimes, and have thus consciously or unconsciously chosen not to charge for the full effects of wear and tear on the track.

There is even less agreement or evidence on how far other cost elements should enter into marginal social cost. To what extent are train planning costs, costs of providing stations, depots or marshalling facilities fixed regardless of use? If there is a true marginal cost of train planning then it seems likely to depend on the number of paths planned, with perhaps some allowance for the complexity of the path. Where a charge is levied for pure congestion effects it should be a charge per train kilometre but differentiated in time and space; where for scarcity, it could take the form of a reservation fee.

Environmental costs will vary with train weight, speed, type of traction, and location. Where charges do exist to cover such costs they are generally much simpler charges, for instance related to fuel used. Such charges should not go to the infrastructure manager in circumstances in which they could create a perverse incentive to encourage environmentally damaging train kilometres.

We have found a wide variety of structures and levels of charges in the various countries of the European Union. There is good reason for differences in terms of the nature of the traffic and the degree of government support received. However, there is little doubt that the current situation makes life difficult for operators of international freight, in terms of transparency of charges, in terms of confused incentives (for instance short frequent trains could be cheapest under one country's regime and heavy infrequent trains under its neighbour's) and above all the level of charges in one country may be prohibitive in terms of international traffic involving transit of that country.

Thus a greater degree of uniformity would be beneficial. To the extent that this cannot be achieved, there may be a case for the implementation of special international tariffs, jointly negotiated by all the infrastructure managers in a particular corridor with reference not just to their costs but also to market conditions in that corridor as a whole. By applying mark-ups based on conditions in the corridor as a whole it should be possible to raise the total amount of revenue achieved by any specific

amount of traffic, and thus to negotiate a scheme for sharing the revenue that benefits infrastructure managers in the corridor as a whole, as well as being beneficial for overall resource allocation.

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