Opening of the European Railroad Network: A Lost Opportunity for European Unification

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The opening of railroad infrastructure to new transport operators in Europe has made it necessary to develop a pricing system for its use. The European Union's transport policy has proposed guidelines for establishing similar pricing system for all EU members. However, while there are some commonalities, today's pricing systems differ substantially from one country to another. These differences reduce continuity between networks and distort the competition conditions between countries, both of which are negative aspects for domestic trade. This paper analyzes the pricing systems of eight European countries and presents several proposals for harmonizing pricing systems.

INTRODUCTION

The European Railroad Network is, in principle, a powerful tool for communications between European countries and, consequently, an aid to their economic development. However, the differences which exist between national railroad systems hinder continuity between networks, seriously limiting the possibilities for rail transport. These differences are technical (track gauge, communication and traffic control systems, loading gauge, electrification systems …), administrative (lack of coordination between railroad companies), regulatory (safety certificates and approval of rolling stock…) and also staffing (in terms of knowledge of infrastructure, communication and traffic control systems, rolling stock and languages).

Another historic problem for railway transport in Europe is the constant loss of competitiveness compared to road-based transportation. One cause for this situation has to do with the structure of railroad companies: until very recently, each country had one major state company in charge of infrastructure management and the provision of transport services (which effectively created a monopoly for rail transport). The inefficiencies inherent in this system have led to a continuous loss of market share for rail transport.

In order to solve the aforementioned problems, the European Union (EU) has published several White Papers (documents which offer guidelines to member countries) and Directives (documents with range of laws). Firstly, EU Directives 91/440/EEC and 2001/12/EC, started the reorganization of national companies, separating the management of infrastructure from the provision of transport services. This made it possible for an independent institution to manage rail infrastructure as a first step to provide fair access to all who are interested in providing transport services; in other words, it opened a gate to the liberalization of railroad transport.

Once the opening of the European railroad network was started through these EU Directives, the next step was to attempt to harmonize the approach different countries used to set charges that the operator must pay to use the system. The EU has published the White Papers COM(1998)466 and COM(2001)370 and the Directives 95/19/EC and 2001/14/EC dealing with this subject. These documents propose general criteria about pricing railroad infrastructure. Nonetheless, despite the intentions of the aforementioned documents, the pricing systems adopted by different governments differ substantially.

While the idea of opening national rail networks to all operators is excellent, the fact that different countries have adopted vastly different infrastructure use pricing systems represents a lost opportunity to simplify the process thereby increasing rail network continuity and increasing the market share for rail. Under current conditions the situation is not a great advance since, previous to the network opening process, train circulation through several countries was also possible by means of agreements between the national rail companies. The objective of this research is to describe the different pricing systems currently in use and to make recommendations for harmonizing pricing systems throughout the European rail network.

CHARGING SYSTEMS

There are two main objectives for pricing transportation infrastructure: cost recovery and reduction of externalities. When costs are paid by the infrastructure user they are said to be "internal costs", and when these costs are imposed on third parties and not reflected in prices they are called "external costs or externalities".

Broadly speaking, European countries have adopted two basic types of pricing systems for railroad infrastructure:

- Simple Tariff – A simple tariff is composed of several variable charges depending on actual infrastructure usage.
- Two-Part Tariff – A two part tariff is composed of a fixed-price component (often called an access charge. Its price is not always strictly fixed, while it can be related to some factors like the planned use of capacity) and a variable-price component (based on use) (1).

The most relevant aspects of the rail infrastructure charging system for eight different European countries are outlined below.

Denmark

Table 1 summarizes the rail infrastructure pricing systems in Denmark, Sweden, and Switzerland. In Denmark, as in the other countries of Northern Europe, the objective of reducing external costs of the transportation system (in this case, by transferring traffic from roads to railroads) prevails over the objective of cost recovery. Therefore Denmark's pricing system includes subsidies for freight trains. Denmark's pricing system is based on a simple tariff (with the exception of a very low access fee per year and km for freight trains) (2).

France

Table 2 summarizes the pricing systems for France and Germany. France has adopted a two-part tariff in order to recover as many costs as possible. It is important to notice that due to the existing congestion, charges are highly variable attending to traffic density (3).

Germany

The German pricing system (Table 2) seeks to recover full costs (4). Originally, it was based on a two-part tariff, but in response to the complaints of some operators (the two-part tariff discriminates against small operators, due to the requirement to pay the fixed part regardless of traffic), the system was reformed in 2001. The reform changed the system and reduced it to a simple tariff fully based on infrastructure use (5) (with charges set at a higher level than marginal costs).

Italy

Table 3 summarizes the pricing systems for Italy and Spain. Italy's pricing system seeks to recover full costs by using a two-part tariff with the peculiarity of adding two different access fees: an access charge for sections of the main lines and an access charge for nodes (mayor rail nodes and main suburban areas). The variable part includes the circulation charge and provides discounts for specific traffic types (6).

Spain

The Spanish rail infrastructure pricing system (Table 3) is defined in the Railroad Law (7). This new regulatory framework aims to sustain the economic viability of both the infrastructure manager and the national operator; therefore, it tries to recover as many costs as possible while allowing the operator to make a profit. A two-part tariff is used; its principal difference from systems in other countries is the inclusion of a variable fee (in order to cover financial costs) that depends on the benefits obtained by the operator.

Sweden

In 1988, Sweden was the first European country to divide the rail infrastructure management from the provision of transportation services. At the same time, Sweden established its rail infrastructure pricing system (8). In 1999, the system evolved from a two-part to a simple tariff. Sweden's simple tariff includes some external costs (Table 1). It is notable for its absence of traffic control charges (6, 9).

Switzerland

Switzerland's central position in Europe means that most traffic between Northern Europe and Italy passes through the country. This fact, linked to its mountainous geography, highly valued environment and the strong social conscience of its people in environmental questions, has promoted a transport policy which is completely orientated to the transfer of traffic from road to railroad: on one hand, the truck roadway charging system subsidizes the construction of the basis railway tunnels through the Alps; on the other hand, freight trains are

subsidized (Table 1). The railroad system reform is so advanced that there has been open access for both national and international railroad operators since 1999. Furthermore, there is a single path selling agency and a common charging system (based on a simple tariff) for Switzerland's three infrastructure managers.

United Kingdom

Table 4 summarizes the pricing system in the United Kingdom (UK). The pricing system was based on a two-part tariff with a major fixed part. This aggressive system has been softened somewhat after the disappearance of *Railtrack* (a private company which owned and managed the rail infrastructure) and the creation of *Network Rail* (a non-profit-making, semi-public company) in 2002. After this change, the new infrastructure manager does not need to make a profit. This has made it possible to increase infrastructure maintenance and improvement investment as well as to reduce charges levied on operators. The charges reduction consisted on the removal of the fixed part for open access passenger services and freight contracts. Nowadays both of them pay only variable charges (4, 10, 11).

RAILROAD INFRASTRUCTURE PRICING SYSTEMS: POINTS OF AGREEMENT AND DISAGREEMENT

This section summarizes some of the main points of agreement and disagreement for the eight European countries analyzed in this research. It must be noted that the deregulation process is at a different level in each country (in some countries, it is only at legislative level, whereas in others it is already in operation). Therefore, the analysis can be considered provisional.

Pricing System Principles

The pricing systems for the use of railroad infrastructure in Europe have been developed following two different approaches: the Marginal Social Cost (MSC) and the Full Cost (FC) approach.

Marginal costs are the costs generated by an additional transport unit when using infrastructure. Infrastructure costs can be divided into fixed (infrastructure construction is the simplest example) and variable (maintenance and conservation costs, power supply to electric trains, etc.). Of the variable costs, some will vary only loosely with the level of traffic. In other cases there are clear links with traffic flows and between the individual transport units and the costs imposed. It is this subset of variable costs which are defined as marginal costs (12). The adjective "social" refers to the inclusion of both internal and external costs.

Full costs include both fixed and variable costs.

The MSC Approach

Under the MSC approach, the pricing system attempts to recover the marginal costs related to railroad traffic operation and management, maintenance of infrastructure and some external costs (air and noise pollution, accidents). The charging system is based on the "simple tariff". Charges are low as is the amount usually recovered. Under this approach, state subsidies for railroad infrastructures are very important, since they are needed to pay the difference between costs and the low income recovered through charges. This system has been adopted in Denmark, Sweden and Switzerland.

The FC Approach

Under the FC approach, prices are established to recover above marginal costs, and as close as possible to total costs. This means that all train operation costs (administrative, traffic management and communications) and maintenance costs are considered, both fixed and variable, including some financial costs. In order to achieve this objective two approaches are used: "Ramsey prices" and the two-part tariff. The first one applies mark-ups on top of marginal costs attending to "Ramsey prices" (higher costs are charged to that traffic that is less sensitive to prices); it has been adopted in Germany and in the UK (for non franchised services). The second approach is based on a two-part tariff with a fixed rate for access, and a variable part including several charges based on marginal costs; this system is used in France, Italy, Spain and the UK (franchised services). In practice, the system does not recover full costs, and as a consequence, subsidies are still necessary, but since charges are higher than under the MSC approach, state funding required in the FC approach is lower.

Objectives

To a greater or a lesser extent, all pricing systems share a common objective: cost recovery. The EU proposes setting charges at marginal costs, allowing mark-ups where the market can bear them. Moreover, European transport policy includes some other complementary objectives in order to enhance the efficiency of the transport system (i.e. encourage freight traffic to use rail).

1) Recover Costs

The level of cost recovery is higher in those countries with the FC system, reaching from 35 to 65% of total cost, while those countries with the MSC approach are only achieve to recover between 5 and 30% of maintenance and traffic management costs (1, 13).

2) Increase Railroad Network Efficiency

Demand management is used to optimize infrastructure capacity. This objective is achieved by setting different prices for each path depending on congestion, infrastructure features and the aptitude of operators to make maximum use of the infrastructure capacity. The more congested the rail network, the more important it is to achieve this objective, so demand management is a corner stone of the pricing systems of Germany, France, UK, Switzerland and Italy.

3) Reduce and Internalize External Costs of Transport

Two main strategies are used for achieving this objective. The first one consists of transferring traffic from road to railroad by means of removing the fixed part of tariffs (Germany, UK) and establishing subsidies or discounts for freight and intermodal trains (Denmark, Switzerland, Italy). Few countries have established measures in their charging systems in order to internalize the external costs of rail transport. They have done this by estimating the external costs and including them in the pricing system through the diesel, noise and accident charges (Sweden, Switzerland).

4) Harmonize Intermodal Competence Conditions

This objective attempts to create similar pricing systems for different means of transport. This has been taken into account in order to develop some charging systems (Sweden, France). In Sweden a similar charging system has been developed for railroad and road (8).

Infrastructure Use: Costs and Charges

This section relates the costs considered in the different pricing systems to the prices imposed to recover them. The names used for the charges are the most common ones, but they are not the same in every country. Table 5 shows the relation between the generic names used below and specific names in each country.

Traffic Management and Administrative Costs

Access Charge. Generally, the countries that have adopted the FC approach recover fixed costs (traffic management and administrative costs are mainly fixed costs) using a so-called access charge, which is the fixed part of the tariff. The total amount of the charge usually changes according to the length of track reserved and duration of the contract, but it is independent of the circulation of the train (in fact, it is paid in advance). The price also varies according to infrastructure characteristics (features and traffic density) and type of traffic (mainly passengers/freight). The access charge is fairly uniform, except in Italy, where the access charge depends not only on the length of paths reserved, but also on the length of time spent in certain areas. Today, several countries have reduced or removed the fixed part of tariffs (UK, Germany).

Circulation Charge. At the outset it should be noted that there is no transparency about this charge, since it recovers a great variety of costs: in some countries it recovers not only traffic management costs, but also maintenance costs (Spain, France). Furthermore, there is no uniformity regarding the measurement units used, although most countries base circulation charges on the train-km indicator.

Financial Costs

In terms of infrastructure funding, the replacement of railroad infrastructure assets via charges is not even considered to be an objective in any of the studied countries. At most, the infrastructure pricing system tries to recover a portion of the financial costs needed (e.g. interest) to fund infrastructure improvements, or to fund specific infrastructure projects (bridges, stations, gauge-changers).

There is no uniformity about the recovery of financial costs: first of all, there is an attempt to recover these costs only in those countries with FC system, charging them both to the **fixed part** (UK, France), and to the **variable part** (traffic charge in Spain and incremental costs charge in the UK). As exception, the Swiss system recovers some financial costs from the contribution margin (1). Therefore, the degree of subsidization of financial costs varies substantially from one country to another.

A certain approach is observed in specific infrastructure funding, which is paid directly depending on use (as a kind of toll in Denmark and Spain) except in Sweden, where it is complemented by a charge paid in the whole network.

Congestion Costs

As expected, in countries, where there are fewer congestion problems (Northern Europe), these charges are infrequent, whereas in countries with congested networks these charges are quite relevant in the charging system. In general, there is a similar way of handling congestion charges, by separating congestion costs on the track network (line) from the scarcity of space in stations.

Capacity Charge. This charge aims to reflect the congestion costs (delays caused by an additional circulation on a congested line) and the scarcity costs (opportunity cost of an operator that cannot run his train as he wishes, because the path has been given to another operator). Approaches to this charge are quite uniform: first, the network is divided in sections in order to improve the management of its capacity; then, paths are set out combining these sections and assigning them a schedule, so a train can go from one place to another at a specified time of day. Next, the path prices are set in accordance with the characteristics of each section (capacity, speed and traffic level) for each period of time. Finally, operators are classified depending on their ability to make the best use of the rail network capacity and/or their ability to adapt themselves to the timetable programming of the line. The capacity charge is levied according to the total length of paths reserved, taking into account the fact that the price varies depending on the aforementioned determining factors. There is a lack of information about the reinvestment of the income obtained through this charge.

Access Charge. In France and Italy this charge varies with the level of traffic, and thus it also reflects congestion costs.

Circulation Charge. In Italy, this charge varies with traffic density and time band.

Passenger Stations Charge. This charge reflects lack of capacity in passenger stations. There is certain uniformity in charges for the use of passenger stations: usually the charge is applied on the basis of the time that the train spends in the platform track, the prices vary according to the station's importance.

Secondary Tracks. The use of secondary tracks (both in passenger and freight stations) for parking rolling stock or loading and unloading operations is always charged depending on the number of tracks and the period of time they are used.

Maintenance Costs

Circulation charge. The first point to make about maintenance costs is that there are a great variety of units used for imposing these costs including: train-km, gross ton-km (GTK), fictitious and dynamic ton-km . Moreover, the price actually charged is often modified according to a wide range of concepts including: wear and tear produced on the rails by each type of train, and type of service (passenger or freight). Finally, as with other charges, this charge displays a lack of transparency since in some cases, it aims to recover a great variety of costs (traffic management, maintenance and conservation costs...). In the UK this charge also covers track renewal costs (1).

Use of Auxiliary Services and other Facilities

While the charging systems examined in this research include a great variety of auxiliary services and facilities (rolling stock depots, railroad repair shops, communication networks, fuel supply...), this section describes the approach adopted for the two most important: traction electricity and freight stations.

Traction Electricity. There is no uniformity in terms of charges for traction energy: in some cases it is charged depending on actual consumption measurements (through on-board meters in Switzerland) and in other cases it is estimated based on consumption rates for each vehicle (France, UK); some countries are currently changing their system from estimated to actual consumption (Germany, Spain). The levying of electrification facilities maintenance costs is another point of disagreement: while Spain uses a specific charge (pantograph-km) France and the UK use the generic traction electricity charge for this purpose. Furthermore, price discrimination based on the consumption time is possible only in Switzerland.

Freight Stations. Charges for the use of freight stations and similar facilities, such as marshalling yards and intermodal terminals, are uniform among the countries evaluated in this research. Costs are charged to operators depending on the number of tracks and the time that they are used. Prices usually vary in relation to the importance of the station. The services associated to this kind of facilities (e.g. the shunting service) are paid according to the level of use.

External Costs

Most countries do not include external costs of transport in their rail infrastructure pricing systems, and when they do, their approaches differ substantially. In some cases, rail transport is subsidized to encourage the transfer of traffic from road to rail (thus reducing the external costs of the transport system as a whole): Denmark and Switzerland subsidize freight traffic. In other cases, charges increase for rail transport with higher externalities: Switzerland and Sweden impose extra charges to diesel trains, to internalize the additional air pollution caused by this kind of traction; accidents are only taken into account in Sweden, and noise in Switzerland.

THE COMPLEXITY OF DIVERSITY

The variation in the structure, charging parameters and costs recovered by the national pricing systems for rail infrastructure in Europe does not help encourage integration of the European railroad sector. Today, the complexity caused by this variation makes it difficult for an operator to have a clear idea of the price he will be required to pay when circulating through different national networks, as shown in Table 6, and furthermore, the different level of cost recovery inherent in each country's pricing system causes important variations in the price to pay depending on which country the train has to go through.

As stated in the Directive 2001/14/EC, the lack of coordination and equity in competence conditions between countries due to the existing pricing framework is one of the reasons that makes railroad less attractive for transport operators. This situation can be illustrated by observing that while the annual transport growth rates in the EU has been of 1.7% for passengers and of 2.7% for freight since the rail deregulation process began (1991), the market share for railroads has hardly changed, reaching now only 7.8% for freight and 6.4% for passengers (while road moves 45% of freight and 80.8% of passengers in Europe) (14).

This means that despite the recent growth in European transport demand, the railroads have captured only a marginal part of it, so it can be said that the deregulation process (designed to encourage the entrance of new operators as a way to improve railroad competitiveness) has not been successful at increasing the share of rail transport. In fact, in most European countries (with the exception of the UK and, to some extent, Sweden, Switzerland and Germany), rail competition is still in an embryonic phase (15, 16). Despite of this, the positive impact of introducing competition can be illustrated with the following cases.

In the UK the share of railroad in the freight market grew to 11% in 2002 from less than 7% in the beginning of the liberalization process (15), and transported tons have grown 45% (16). In Germany an important growth of rail transportation has accompanied the deregulation process: 30% respecting to passengers rail transportation and 14% respecting to freight transportation since 1997 (17). Finally, rail market share in passengers transportation has grown 32% in Switzerland between 1991 and 2001 (18).

With respect to international transport, finding private operators running trains through different countries is difficult. The two main international passenger rail services (Thalys and Eurostar) are provided jointly by the public rail companies of the involved countries (private operator in the case of the UK). Both experiences have achieved good results. The Thalys service has doubled the share of railway traffic in the Paris-Brussels corridor (19), and the Eurostar became the rail/air market leader and doubled the total number of passengers traveling between London and Paris-Brussels short time after its creation (20). In terms of international freight transport, the most important international operator (Railion) arose from the merge of DB

Cargo, NS Cargo and DBS Cargo, again a merge of national public companies (German, Dutch and Danish respectively). These kinds of merges are achieving good results (16). While most international freight trains are consequence of agreements between national companies, it is possible to find private operators carrying goods along the whole continent. They are associated in the International Union of Private Wagon (UIP) and they carry out the transport of approximately half of the tons-km done through rail in Western Europe. Usually the traction service is supplied by the national rail companies. Although it has to be noted that most of these private operators began service prior to the liberalization process (21).

For both passenger and freight transport, therefore, it can generally be said that the effects of the liberalization process at an international level have been weak. Not even the establishment of international rail corridors free from obstacles such as complex administrative procedures and long waiting time at borders (the so-called freeways and freightways) has caused a significant number of new companies to enter the market, with the result that these corridors are not fully utilized (22).

CONCLUSIONS

The comparative analysis set forth above shows a great diversity among the pricing systems used in the analyzed countries. Consequently, the EU's objective of unifying the pricing systems for use of railroad infrastructure in Europe is still far from being achieved.

The basic objective of tariffication, that is to say, the cost recovering, represents the start of a series of divergences in terms of approaches and results between the different countries. On the one hand, those countries that aim to recover FC have adopted pricing systems that mark-up variable charges above marginal costs (attending to Ramsey prices) and include fixed charges through a two-part tariff system. On the other hand, those countries where cost recovery is not the main priority have adopted a MSC pricing system to cover marginal costs through a simple tariff using only traffic-based charges. In general, the Northern European and environmentally friendly transport policy countries tend to use the MSC approach while the rest use the FC approach. Some countries with the FC system have recently reduced or even removed the fixed part of tariffs.

In terms of the complementary objectives proposed by EU transport policy (increasing railroad efficiency, reducing external costs of transport and the harmonization of intermodal competence conditions), the encouragement of railway transport is a permanent goal of every national transport policy, both by increasing efficiency and establishing policies to assist the transfer of traffic from road. On the other hand, the development of similar infrastructure pricing systems for different means of transport and the internalization of external costs do not seem to be a priority among the countries analyzed as part of this research.

As expected, rail infrastructure charges are higher in those countries which have adopted the FC approach than in those which have adopted the MSC approach. Subsidies appear in every country, although state funding is much higher in countries with a MSC system.

In general, there is no uniformity regarding the charges adopted in each country's pricing system neither in the costs that they recover or the measurement units. There are some exceptions: certain unanimity is observed in the establishment of the access charges; there is also a common criterion regarding the prices imposed for the stations utilization (both for passengers and freight stations) and capacity charges. With regard to charges for recovering traffic management and administrative costs and maintenance costs, there is neither uniformity (due to the great variety of charges, parameters and price-modulating conditions used for levying these costs) nor transparency (sometimes costs of different nature are recovered from the same charges and the relation between some charges and the costs recovered is unclear). The charging approach for traction electricity supply and financial costs is also very different. External costs have been included in a small number of countries; however, the externalities taken into account and their treatment vary from one country to another.

Another point of difference is whether the network must be divided or not and the extent of this division: countries of Northern Europe adopt almost a unitary treatment of their rail network, while the rest of the countries divide the network in sections (in order to make possible the development of a path system to allocate the capacity of the lines between operators), or even in areas (nodes in Italy) depending on the quality of the infrastructure and on the level of traffic. The extent of division of the network is set according to the level of congestion suffered by the country's network: the more important congestion is, the more complicated the division is.

This complexity derived from the differences between the national regimes makes international train operations more difficult, and thus it is limiting rail transportation competitiveness.

Bearing in mind the different geographical, economic and socio-cultural characteristics of the European countries, it seems that the solution cannot be the same for all countries, although a certain unity is essential. With those caveats, this research supports the following conclusions:

- Rail infrastructure pricing systems should have a common structure; taking into account the experience evaluated in this research and the EU transport policy, the most appropriate

charging system to encourage greater use of railroad transport seems to be a simple tariff fully based on traffic (variable).

- It may be acceptable to fix charges above marginal costs according to Ramsey-prices to achieve a higher level of cost recovery, depending on each country's financial objectives, but limiting the differences between prices, especially in neighboring countries.
- Pricing system charges must be transparent. In other words the rail operator should clearly identify charges with the costs they are intended to recover. In order to achieve this objective, detailed studies on costs are essential (infrastructure managers should invest on this research area) and each charge should be linked to a whole range of costs of the same nature (that is to say: one charge related to maintenance costs, another related to traffic management, and so on).
- The inclusion of externalities is probably a less urgent matter in terms of harmonization, due to the great differences that exist among European countries about this subject, but a common approach is desirable.

The implementation of these unification proposals (Figure 1 shows a simplified harmonized pricing model) would be of great benefit to the European railroad system, helping make the pricing system more transparent as a whole and unifying competitive conditions among countries. The adoption of a similar charging system for road transportation would further enhance the efficiency and competitiveness of the European transport system. Further unified research on transport costs an on the developing of similar charging methodologies is essential to support this process.

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List of Tables and Figures

TABLE 1 Charging Systems in Denmark (2, 17), Sweden (8, 9) and Switzerland (1, 13, 23)

DENMARK		
CHARGE	CHARGING PARAMETER	COMMENTS
Kilometre charges	Train-km	In the whole network except in two lines.
Bridge tariff	Per journey	- Great Belt (passengers' and freight trains are charged almost equally). - Öresund (freight trains are charged 36% more).
Capacity	Train	Paid only in three lines. The same for passengers and freight trains except in one of them.
Environmental subsidies	GTK	Only for freight trains
SWEDEN		
CHARGE	CHARGING PARAMETER	COMMENTS
Track charges (passengers)	GTK	
Öresund link funding (passengers)	GTK	Passenger trains circulating in the whole network contribute to the funding of the fixed link across Öresund. Empty passenger trains are charged only for maintenance.
Track charges (freight trains)	GTK	
Öresund link funding (freight trains)	Per journey	
Information for passengers	Depending on the amount of information	
Accidents	GTK	
Diesel charge	Per fuel liter	It aims to internalize the additional environmental costs of this kind of traction.
SWITZERLAND		
CHARGE	CHARGING PARAMETER	COMMENTS
Maintenance	GTK	60% subsidized for intermodal freight transport.
Train operation service	Train-km	It refers to the costs of traffic control management and communications.
Energy	kWh (kilo Watt per hour)	-Night fee: 36% cheaper -Based on actual consumption (on-board consumption meter).
Charge for diesel	GTK	When using electrified lines.
Nodes (junctions) and stations	Per commercial stop	The price varies depending on the node category. It recovers staff and maintenance costs in these facilities.
Contribution margin - passengers	- % of revenues - seats-km	It is set for each case. It varies between regional (14%) and long distance trains (4%). It helps to fund capital costs (finance new routes, network improvement)
Contribution margin – goods	NTK (net tons-km) or GTK	It is set for each case. Subsidized.
Noise reduction bonus	Axle-km	For using less noisy rolling stock
Train path option	Per path	The price varies depending on the priority on schedule planning and the level of congestion
Secondary track	Per time	Secondary track: track used for parking trains (not used for regular train movements)
Marshalling yards	Per shunting movement	Subsidized

TABLE 2 Charging Systems in France (3, 24) and Germany (6)

FRANCE		
FIXED PART Access charge: payable per km and month. Varies depending on line characteristics (traffic level and equipment). Subsequently, a modulation coefficient is applied depending on the duration of the contract and the number of paths reserved. It covers interests and helps financing network improvement.		
VARIABLE PART		
CHARGE	CHARGING PARAMETER	COMMENTS
Capacity: paths reservation	km	It depends on the type of line, type of train (passengers, freight trains) and the time of use. In intercity lines with medium and high traffic level varies depending on train speed (the slower the train is, the higher the charge becomes). It takes into account the greater schedule flexibility of freight trains and empty ones.
Capacity: reservation of stops at stations	Per stop	In intermediate stations (only for suburban trains). Stops in departure/arrival stations are charged separately.
Running charge	Train-km	It varies depending on the type of train (passengers, freight trains, empty). It affects operating, traffic management and network maintenance costs.
Multimodal terminals	Per month of use	The price depends on the terminal.
Marshalling yards	Number of tracks used /month	It varies depending on the importance of the station.
Secondary track	Time	Freight trains: for parking a train longer than one hour on some tracks.
Traction current	Train-km	Based on estimated consumption rates. It covers also part of the maintenance costs of substations and air lines.
Transmission of electricity	Train-km	It affects the costs of connection to the electricity supplier and upstream losses in the RFF network.
Futuroscope station	Per month	It recovers the investment made by RFF in this facility
GERMANY		
CHARGE	CHARGING PARAMETER	COMMENTS
Base price	Train-km	It depends on the type of line (equipment and level of traffic)
Path products	Product coefficients	The product coefficients are multiplicative surcharges applied to the base price, varying between 0,50 and 1,80 depending on the quality of the path (priority in timetable planning) and type of traffic (passengers/freight)
Surcharges	Multiplicative surcharge	This multiplicative surcharge goes between 1,20 and 2,45 for steam traction, out-of-gauge-load and regional services
Surcharges	Additive (per train-km)	Extra weight trains, extra weight axle load and tilting trains. Varies between 0,00 and 1,33 train-km
Traction electricity	kWh (kilo Watt per hour)	Changing from estimated consumption rates to actual consumption (on board meters)
Passenger stations	Per stop	It varies depending on the importance of the station and on the train capacity
Freight stations	Number of tracks /time	

TABLE 3 Charging Systems in Italy (6) and Spain (7, 25)

ITALY		
CHARGE	CHARGING PARAMETER	COMMENTS
FIXED PART		
Access charge to sections of the main lines: fixed price (EUR/km) depending on the level of traffic Access charge to nodes: paid by time of stay (1 EUR/min)		
VARIABLE PART		
Usage costs	?	Varies with congestion and train characteristics (speed and weight)
Supplementary charge: main stations	?	
Supplementary charge: traction electricity	?	
Discount: local trains	?	For services shorter than 120km. Discount vary with congestion and infrastructure quality
Discount: traffic volume	Train-km	From greater to smaller discount: freight trains, long-distance and short-distance passenger's trains
SPAIN		
FIXED PART		
Access charge: varies according to length of track reserved and type of traffic (passengers/freight). It recovers administrative costs		
VARIABLE PART		
CHARGE	CHARGING PARAMETER	COMMENTS
Capacity	Km	It affects fixed costs of maintenance, trains operation and traffic management.
Circulation	Fictitious TK (train-kilometer) Dynamic TK Pantograph-km	Path price depends on the type of line, service, train and time of day. - Fictitious TK depends on the type of train, weight and speed. - Dynamic TK depends on the relation between the dynamic charge caused by the train and the strength of the rail. It affects variable costs of maintenance, trains operation and traffic management.
Traffic	Commercial value of the trains capacity: seat-km, TK, TEU-km (twenty foot equivalent unit-kilometer)	Passenger trains: the traffic charge increases depending on the speed of the train and the duration of the journey. Moreover it varies depending on the type of train and the time band. It affects financial costs, replacement and infrastructure improvement costs.
Stations: Charges on passenger services	Per passenger get on/off a train	It varies depending on the importance of the station, and length and duration of the journey.
Stations: Charges on track platform use	Per usage time	It varies according to the importance of the station. Intermediate commercial stops are not charged.
Charges for the use of gauge changer	Per usage	
Stations: charges for the use of secondary tracks	Per usage time	Varies according to the type of train and the line.
Traction electricity	Traction electricity: MWh (Mega Watt per hour)	Electricity: consumption according to on-board meters + losses in transport and energy transformation.

? Unavailable data

TABLE 4 Charging System in the United Kingdom (26, 27, 28)

UNITED KINGDOM		
FIXED PART		
Fixed track charge: for franchised passenger services. Recovers financial costs (interests, major infrastructure improvements funding) and fixed costs (administrative and traffic control costs)		
VARIABLE PART		
CHARGE	CHARGING PARAMETER	COMMENTS
Variable track usage charge	Train-mile	It varies depending on the rolling stock characteristics and commodity type being carried (freight trains). It recovers maintenance and renewal costs
Traction electricity	kWh*train-mile	For multiple unit trains. Based on estimated consumption rates. It includes costs of maintaining and renewing the electrification assets
	Wh*gross ton-mile	For locomotive hauled services. Based on estimated consumption rates. It includes costs of maintaining and renewing the electrification assets
Capacity charge	Capacity consumed	Depending on the expected increase in congestion costs
	Penalties	For occasional delays and cancellations. Penalties imposed on operator/infrastructure manager depending on who is responsible of the anomaly
	Discounts	For freight trains, due to their flexibility in timetabling
Incremental costs	?	For network enhancements funding and additional operating costs
Stations	?	Through access contract with the station facility owner
Depots	?	Through access contract with the depot facility owner

? Unavailable data

TABLE 5 Generic and Specific Charges Names

	Access Charge	**Circulation Charge**	**Capacity Charge**	**Passenger Stations Charge**	**Secondary Track Charge**	**Traction Electricity Charge**	**Freight Stations Charge**	**Externality Charges**
Denmark	-	Kilometre charge	Capacity	-	-	?	?	Environmental subsidies
France	Access	Running charge	Capacity: paths reservation	Capacity: reservation of stops at stations	Secondary track	Traction current Transmission of electricity	Multimodal terminals Marshalling yards	-
Germany	-	Base price Surcharges	Path products	Passenger stations	?	Traction electricity	Freight stations	-
Italy	Access to sections Access to nodes	Usage costs	Access to sections Access to nodes Circulation	Main stations	?	Traction electricity	?	-
Spain	Access	Circulation	Capacity	Track platform	Secondary track	Traction electricity	-	-
Sweden	-	Track charge	-	-	-	?	?	Accidents Diesel
Switzerland	-	Maintenance Train operation	Train path option	Nodes	Secondary track	Energy	Marshalling yards	Diesel Noise reduction bonus
United Kingdom	Fixed track charge	Variable track usage charge	Capacity	Stations	Stations	Traction electricity	Stations Depots	-

- Charge not included in the charging system ? Unavailable data

TABLE 6 Costs and Charges

	Traffic Control Management & Administrative Costs	Financial costs	Congestion Costs	Maintenance Costs	Auxiliary Services & other Facilities	External Costs
Denmark	Kilometre* (train-km)	Bridges (per journey)	Only in 3 lines Capacity (per train)	Kilometre* (train-km)	?	Enviromental subsidies (GTK)
France	Running charge (train-km)	Access (per km and month)	Access (per km and month) Paths reservation (path-km) Stations (per stop) Secondary track (per time)	Running Charge (train-km)	Traction current: estimated consumption (train-km); includes facilities maintenance. Multimodal terminals (per month) Marshalling yards (tracks/month)	-
Germany	Base price (train-km) Surcharge	Base price* (train-km)	Path products	Base price (train-km) Surcharge	Traction electricity: estimated and actual consumption (kWh) Passenger stations (per stop) Freight stations (tracks/time)	-
Italy	?	Access to sections* (km) Access to nodes* (min)	Access to sections (km) Access to nodes (min) Usage costs (?) Main stations (?)	Usage costs (?)	Traction electricity (?)	-
Spain	Access (km) Capacity (km) Circulation (Fictitious TK, Dynamic TK)	Traffic (seats-km, TK, TEU-km) Gauge changer (per use)	Capacity (km) Stations: use of platform and secondary tracks (time)	Capacity (km) Circulation (Fictitious TK, Dynamic TK)	Traction electricity: actual consumption (MWh). Maintenance (pantograph-km) Information (per passenger)	-
Sweden	-	Track charges (GTK) Öresund link (per journey)	-	Track charges (GTK)	Information for passengers	Accidents (GTK) Diesel (fuel liter)
Switzerland	Train operation (train-km)	Contribution margin* (% revenues, seats-km, NTK)	Nodes and stations (commercial stop) Secondary tracks (time)	Maintenance (GTK)	Energy: actual consumption (kWh). Price discrimination Marshalling yards (per shunting)	Diesel (GTK) Noise reduction bonus (axle-km)
United Kingdom	Fixed track charge Incremental (?)	Fixed, Variable track (train-mile) Incremental (?)	Capacity (capacity consumed, penalties, discounts)	Variable track (train-mile)	Traction electricityy: estimated consumption (train-mile, gross ton-mile)	-

** Not confirmed Cost-Charge relation - Cost not included in the charging system ? Unavailable data*

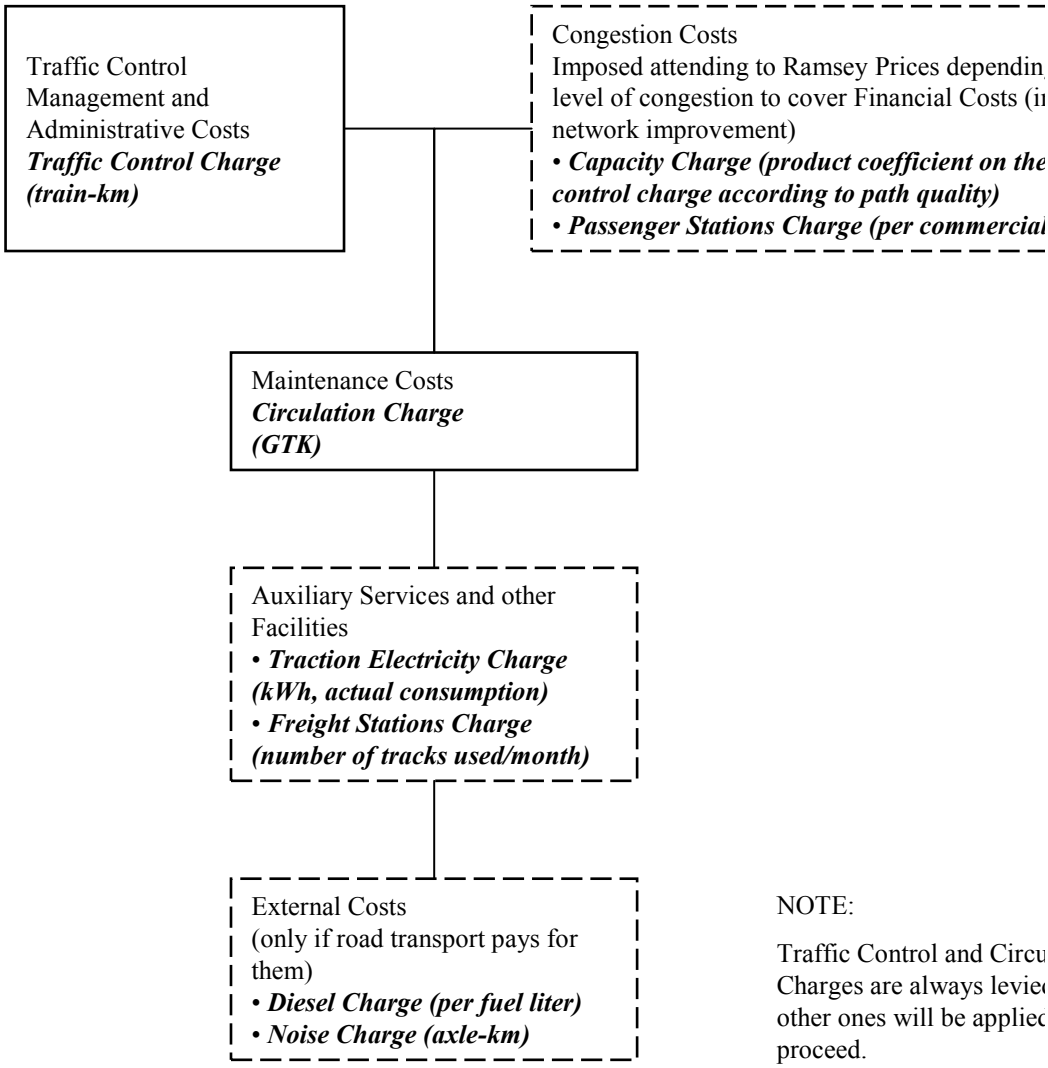

FIGURE 1 Proposed Pricing Model